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TECHNOLOGICAL AND TECHNICAL EDUCATION IN BRITAIN

THE very guarded statement which the Chancellor of the Exchequer made in the House of Commons on July 13 indicates that official policy for technological education in Great Britain is at last taking shape, though there was no indication of any policy for technical education which should be developed *pari passu*. As already noted in *Nature* of July 17 (p. 111), Mr. R. A. Butler stated that, in accordance with his request of July 1953, the University Grants Committee had submitted its report and recommendations for the development of higher technological education outside London, and that, after considering its recommendations, he had approved plans for developments, mainly at Glasgow, Manchester, Leeds and Birmingham. Mr. Butler indicated that provision was also made for developments elsewhere; but that they would take place at institutions already in receipt of recurrent grants on the recommendation of the University Grants Committee. It would be necessary, accordingly, to increase the resources available to the University Grants Committee, both for recurrent and non-recurrent purposes, in the last three years of the quinquennium 1952–57.

The Chancellor is now considering the timing of these developments, some of which, he hoped, would start in the next academic year; and the further statement, which he promised to make in due course, will no doubt give details of the proposed increase in the vote for the University Grants Committee. Those details, if the Government is reasonably generous, should themselves attest the wisdom of the Committee's refusal to disperse over too wide a field the strictly limited allocation which can be spared to higher technological education from the national resources at the present time. Meanwhile, the University Grants Committee has rightly resisted the temptation to spread those resources over six or more institutions as suggested in the Percy Report of 1945, still more over the fifteen or twenty regional colleges suggested in the report on the Development of Higher Technological Education submitted to the summer meeting of the Association of Principals of Technical Institutions and the Association of Technical Institutions* last June. That report, which followed broadly proposals advanced by Principal J. C. Jones to the latter Association in February, was concerned with securing adequate regional cover; but it failed to distinguish between technical and technological education. Nevertheless, the report proposed that the selected colleges should all receive contributions from the central government amounting to not less than 75 per cent of the agreed net expenditure. It was also proposed that these colleges should provide advanced courses and facilities for

*Association of Principals of Technical Institutions and Association of Technical Institutions. Report on the Development of Higher Technological Education. (Summer Meeting—Southport, 10th–12th June, 1954.) Pp. 7. (London: Association of Technical Institutions, The Polytechnic, London, W.1, 1954.)

postgraduate studies and research for a region rather than the area of a particular local education authority, and that, accordingly, they should be financed by grants covering a period of not less than three years and administered solely by a governing body on which the industry and commerce of the region as well as local education authorities should be represented.

It may well be a matter for consideration how far it is desirable for technical education to be given more independence from local authority control; continuity, greater freedom and improved conditions of service for the staff of technical colleges could be bought too dearly if local interest and co-operation should be adversely affected. The development of technical education depends largely on such local interest and co-operation and, to the extent to which they are secured even under the existing arrangements, it should be possible continuously to improve conditions so that staff of the requisite quality is attracted and retained, and provided with the facilities for effective research as well as teaching. What needs to be remembered is that the technical colleges are doing a job no less important than, but complementary to, that of the technological institutions. It is not a matter of one type of institution being inferior to the other, but of providing each with the most appropriate conditions for efficiency, and apportioning the available resources between the two types of institution in accordance with the needs of the country.

That is the reason for some doubt, in the absence of fuller information, as to whether the resources available for higher technological education are not even now being distributed too widely. Great Britain clearly cannot afford the resources necessary for developing five major technological institutions of the type of those at Massachusetts or Delft, nor should it be assumed as yet that that is the intention of the Government. All that can be said at present is that the Government's plans contemplate the development of the Imperial College of Science and Technology into a major technological institution of university rank. It can safely be assumed that such development will not diminish the fructifying interaction and intercourse between the pure and applied sciences, or between them and other fields of study which the authorities of that College have shown themselves so anxious to promote. The proposals announced on July 13 appeared to contemplate the development as independent institutions of university rank of the Royal Technical College, Glasgow, and the College of Technology, Manchester; but Mr. Butler's subsequent statement of July 20 seemed to deny this, though in view of existing relations between the latter College and the University of Manchester the position is not clear. Lord Woolton has already indicated that it was contemplated that the latter College should become independent, with its own governing body and a substantial government grant, and the implications of the Government's proposals are already being considered by the Manchester City Council.

The Manchester College of Technology has close ties with the University of Manchester, and Lord Salisbury, during his visit to Manchester, indicated that these relations would be maintained under the new arrangement. Nor is it likely that in the developments at Glasgow there will be any interruption of such interaction and intercourse, or any excessive segregation of specialities. At Leeds and Birmingham it would appear that developments will proceed within the framework of the existing university departments of technology, and so far as the Government's policy is disclosed, accordingly, it would appear to take care of the great danger of segregation against which Sir Philip Morris, Sir Richard Southwell, Lord Eustace Percy and others have warned us so plainly and to be seeking to improve and develop existing institutions rather than create entirely new ones. Three clear lines of evolution can be discerned, none of which appears likely to depart too far or too abruptly from our tradition of multi-purpose institutions, yet all of which would appear to offer reasonable scope for experiment with new ideas and new methods.

Discussion on the expansion of higher technological education in Britain should in future turn more on the tactics to be used rather than on the policy to be pursued, subject to the reservation that no policy for higher technological education will meet the nation's needs without an adequate policy for technical education. Education must be viewed as a whole, and the available resources—finance, materials and man-power—allotted in accordance with some reasoned appraisal of the situation as a whole and of the complex interrelations of which the shortage of science teachers has at least helped to make the nation better aware. Technological education cannot be expanded without due regard to the general needs of the universities, of technical education and of secondary education, and indeed of adult education in general. As the Percy Committee pointed out, technical education needs to be surveyed and planned as a whole, and in the field of adult education as well as in its technological studies it requires co-ordination with university education.

This emphasis of the Percy Committee on diversity of function has frequently been ignored in subsequent discussions. Had the comment of the report that diversity of function is not inconsistent with equality of status between the technical colleges and the institutions specifically for higher technological education been heeded, the futile discussions about awards would scarcely have persisted into the recent report from the Association of Technical Institutions and the memorandum of the Parliamentary and Scientific Committee. Fortunately, some at least of the papers, such as that of Mr. F. H. Perkins, given at the Conference of the Associations of Technical Institutions and of their Principals, showed a clear idea of the situation and of industry's need for both technicians and technologists.

Mr. Perkins, in his paper on industry and technical colleges, to some extent followed ideas expressed by Dr. P. F. R. Venables at the North of England Educational Conference (see *Nature*, January 30, p. 197); but the plan for which he pleaded would concentrate major developments in two or three technical

colleges rather than the twelve or fifteen suggested by Dr. Venables. These, however, would provide full-time and sandwich courses for selected students at an advanced level, organized on a residential basis, in which the students could participate fully in the communal life of the college, much as Dr. Venables had urged. These developments would be accompanied by a further increase in the number of students taking first degrees in science and technology at the universities, so as to reduce a deficiency in the supply of scientists and technologists, which by 1955 is likely to exceed considerably that forecast in the Barlow Report.

This policy, so far as can at present be judged, may be nearer to that which the Chancellor of the Exchequer contemplates than the more diffused programme suggested by Dr. Venables or Mr. Jones. Mr. Perkins was dealing more particularly with industry's requirements for recruits capable in due course of filling its more senior posts. Stress was accordingly laid upon residence, a broad curriculum based on science and strong seminar activities as the most likely means of developing the qualities required. The need will not be met by measures which merely provide increased opportunities for those studying under the handicap of evening classes or long daily journeys to and from home.

The first need is to provide for the expansion of higher technological education in a way which will supply industry with technologists of the calibre and potentialities it requires; but that expansion must not be at the expense of the technicians which it requires in even greater numbers. For the chemical industry, Mr. Perkins said that the number of such men and women with lesser scientific or technical qualifications and experience required is probably about fifty per cent greater. To provide such men and women and also less highly qualified technicians (which for other industries may well outnumber technologists by five to one) is the primary responsibility of the technical colleges and the function which has to be most closely related to local needs. One difficulty in the development of higher technological education at the Manchester College of Technology is likely to be the College's responsibility for providing the local education authority's national certificate courses, a responsibility that cannot be divested until subsidiary colleges are built. The way in which the expansion of technological education is linked with that of technical education could not be better illustrated.

The corollary of the proposals announced by Mr. Butler is in fact a clear statement of the policy which the Minister of Education proposes to adopt in technical education. Of that Miss Horsbrugh gave no sign when she was addressing the annual conference of the Association of Education Committees at Scarborough on June 25. Her claim that at the end of April £12 million had been spent on building technical colleges since the end of the War, another £18 million on those still under construction and that expenditure of a further £4·5 million was projected does not amount to a policy, any more than her reasonable plea for more co-operation between local authorities or her promise to issue regulations which would minimize the causes of friction in financial arrangements.

It is not only, however, in respect of financial arrangements that a lead from the Minister could help to remove friction and foster co-operation. A clear statement of policy and of the resources to be made available for the development of technical education is essential in order to secure the co-operation of industry, and it might also facilitate the establishment of effective relationships between the colleges of technology and the university departments of technology and the technical colleges. As Miss Horsbrugh rightly pointed out, it is not sound or economically possible for the technical colleges to serve all the needs of an area, and the exact means by which needs, and especially the advanced needs, are best satisfied will vary from area to area. But until some overall picture of the Government's policy and plans can be seen, it will be impossible to remove by reasoned argument and discussion the disappointments, sometimes rooted in local jealousies or history, which the wisest selection is liable to engender, and to secure co-operation and goodwill. The goodwill and understanding of the local authorities are essential, moreover, if conditions of service in the technical colleges are to be such as to attract staff of a calibre to undertake usefully either consulting work or research, and to win and hold parity of status with the institutions for technological education.

BRITISH BIRDS

The Birds of the British Isles

By Dr. David Armitage Bannerman and illustrated by George E. Lodge. Vol. 1: Corvidae, Sturnidae, Oriolidae, Fringillidae. Pp. xviii+356+41 plates. Vol. 2: Alaudidae, Certhiidae, Paridae, Vireonidae, Muscicapidae, Motacillidae, Sittidae, Laniidae, Bombycillidae, Regulidae. Pp. viii+302+41 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 45*s*. net each vol.

THIS is a work on British birds in the grand manner, the like of which one had scarcely expected to see again; one gathers that it has been made possible by the artist's creation of a trust fund to subsidize the reproduction of his plates. The work is sumptuously produced, beautifully illustrated, and written in a leisured style with care and distinction. These two volumes are the first of three dealing with the passerine birds; and from this one can estimate that six or seven volumes in all, of which the rest are to be issued over a period of years, will be required for the complete work.

The author and the artist—Dr. David Bannerman and Mr. George E. Lodge—are both past vice-presidents of the British Ornithologists' Union and are already very well known for their work. Shortly after these volumes appeared, one regretted to hear of the death of Mr. Lodge, although at a great age; but he had completed his series of paintings for this work some years ago, and one is happy to know that it will be illustrated throughout with plates in colour by the foremost ornithological artist of our time and

country. These not only serve the purpose of accurate and useful illustration, but they are also pleasing as pictures in high degree.

Dr. Bannerman's professional studies, during forty years at the British Museum (Natural History), have been concerned mainly with the birds of West Africa, on which he is the recognized authority. The present work he describes as the child of his leisure hours, and they have indeed been well spent—in wide reading, in the expert examination of specimens, and notably in the field, all of which forms of study have clearly contributed to the success of the final result. Moreover, he has been at pains to provide a very readable text to match the beauty of the plates, in contrast to the highly compressed summaries with which the writers of most modern works of reference have to be content; in this he has deliberately followed the model of the great ornithologists of a more gracious age, from whose writings he also effectively quotes.

The arrangement is of the usual systematic kind: for each species information is given on identification (with differentiation of races where relevant), distribution at home and abroad, migration, habits and breeding. This is, of course, a well-worked field; but, in addition to bringing information up to date, or amplifying it from hitherto unpublished sources, the author has critically re-examined earlier statements and made his own assessments. (Special acknowledgment is made of the numerous notes supplied personally to Dr. Bannerman by another ornithologist, Dr. H. M. S. Blair.) A special feature is the wealth of information about British migratory species in their other habitats abroad and, where possible, actually on passage: this is a valuable contribution, largely based on Dr. Bannerman's personal observations during the extensive travels that he has for many years undertaken for the express purpose.

There are naturally points on which other experts may differ from the author, some questions of classification and nomenclature being among them. In his preface, Dr. Bannerman indulges some personal views about lines of ornithological study with which he is not in full sympathy; fortunately, however, neither the bionomics of bird populations nor interpretations of bird behaviour are essential to the particular purpose which Dr. Bannerman is in the process of fulfilling so well.

Landsborough Thomson

RESPIRATION IN PLANTS

Plant Respiration

By Dr. W. O. James. Pp. ix+282. (Oxford: At the Clarendon Press; London: Oxford University Press, 1953.) 30*s*. net.

THAT plants, like animals, absorb oxygen and give out carbon dioxide has been known for well over a century; but the significance of this as a feature of an oxidation of carbohydrate or other material by which energy is released only came to be realized later. To emphasize this as the essential characteristic of respiration, Barnes in 1905 suggested the term energesis; and although this term was not accepted by the generality of botanists, almost all plant physiologists have now for many years regarded respiration in plants as including all those processes in which a substrate is broken down with release of energy. Thus processes not involving an oxidation, notably the breaking down of sugar to carbon dioxide and ethyl alcohol, are included in respiration and are distinguished from normal respiration as 'anaerobic' respiration. During the past ten years or so there has been a tendency to limit the application of the term respiration to those processes in which sugar or some other substrate is broken down by oxidation and to use the term fermentation to denote those processes previously known as anaerobic respiration. It is, however, quite impossible to give any detailed account of plant respiration without also dealing with the degradation of sugar in absence of oxygen; and in the opening pages of this treatise on plant respiration Dr. W. O. James gives reasoned and cogent arguments for using the term 'plant respiration' to include all those processes in which complex substances undergo changes that in the aggregate lead to a diminution of free energy.

Dr. James's account of plant respiration is very comprehensive, and the various aspects of the subject are dealt with in detail. The arrangement of the material, if to some degree unusual, is satisfactory and, indeed, successful. The earlier chapters on the rate of respiration, which includes temperature effects, respiratory drifts and the respiratory quotient, deal with information which for the most part has been well established for many years. The following chapter on respirable materials includes a discussion on the important topic of the phosphorylation of carbohydrates. The remaining five chapters of the book, comprising somewhat more than half of the whole text, which are headed glycolysis, oxygen effects, oxidation mechanisms, oxidation stages in respiration and connexions with other processes, deal with what is often described as the mechanism of respiration. It is with the aspects of respiration considered in these chapters that our knowledge of the subject has developed most during the past twenty years, a development which has been brought about in no small measure by Dr. James's own researches. Whereas some twenty years ago so little was known of the course of the breakdown of the respiratory substrate in plants that it was little more than a matter for conjecture, we now have a complete scheme for the course of degradation of carbohydrate to carbon dioxide and water which, if not proved, is at least credible and in harmony with experimentally discovered facts. These chapters, in particular, will be read with interest by all wishing to acquire detailed information of recent work on the mechanism of respiration.

It seems clear that respiration supplies the energy for certain syntheses in plant cells and for the intake of salts into cells against concentration gradients. The problems of the way in which the energy provided by respiration is utilized in these processes are still unsolved, as a perusal of Dr. James's last chapter shows. But many plant cells do not appear to be concerned in such processes or, indeed, in any activity requiring a supply of energy, and yet they respire. What then is the general significance of respiration? This question is dealt with in the concluding paragraphs of Dr. James's book; but he decides that there is at present no valid evidence either in support of, or against, the idea that respiration is essential for protoplasmic maintenance. With this conclusion the present reviewer is in complete agreement, and, indeed, he is far from convinced

that respiration is necessary for cells to remain alive, as distinct from actively living.

Dr. James is to be congratulated on producing a masterly and scholarly monograph on plant respiration in which the researches of more than a century are critically considered and ably presented. This work, by a recognized authority on his subject, forms a valuable addition to the literature of plant physiology.

W. STILES

TREATISE OF PALÆONTOLOGY

Traité de Paléontologie

Publié sous la direction de Prof. Jean Piveteau. Tome 3 : Les formes ultimes d'Invertébrés ; morphologie et évolution ; Onychophores. Par C. Dechaseaux. Arthropodes, Proarthropodes. Par C. Dechaseaux et G. Waterlot. Trilobites. Par P. Hupé. Crustacés. Par C. Dechaseaux, N. Grekoff, J. Roger, H. et G. Termier. Myriapodes, Insectes. Par D. Laurentiaux. Mérostomes, Arachnides. Par G. Waterlot. Échinodermes, Hétérostélés, Cystidés. Par L. Cuénot. Blastoïdes. Par F.-M. Bergounioux. Edrioastéroïdes. Par J. Piveteau. Crinoïdes, Stelleroïdes, Ophiocystoïdes. Par G. Ubaghs. Echinides. Par H. et G. Termier. Holothurides. Par M. Deflandre-Rigaud. Stomocordés, Ptérobranches et Graptolites. Par G. Waterlot. Machaeridiens, Conulaires, Hyolithes, Tentaculites. Par H. et G. Termier. Pp. viii+1063+17 plates. (Paris : Masson et Cie., 1953.) Broché 9,600 francs. Cartonné toile 10,320 francs.

VOLUME 3 of the "Traité de Paléontologie" includes all the Invertebrata not dealt with in the first two volumes. Of editorial practices already criticized[1], authors and dates of the various taxonomic units are still too seldom given, and the type, or any species of the genera mentioned, is too often omitted. Some pre-Linnæan names of Echinoid genera are also included. The scale of magnification of the figures is usually indicated, however, and the high standard of printing and illustration is well maintained.

The Onychophora, scarcely known fossil, are treated in a brief and lucid essay which indicates the importance of this group to theories of annelid–arthropod relationship. An important chapter on the basic characters and phylogeny of the Arthropoda is useful as an introduction to this vast phylum. Of the chapters on the various classes, that on the Trilobitomorpha meets the requirements of a textbook, but the Trilobita are handled in a speculative fashion and numerous new family-group units are proposed. The author's enthusiasm and ability have nevertheless produced a well-documented account with excellent illustrations. The Crustacea are well, if conservatively, dealt with ; but more space might have been allotted to the Ostracoda in view of their economic importance, and no chapter on the Cirripedia can be adequate that ignores the work of the late T. H. Withers, especially his three catalogues published by the British Museum (Natural History). Of the remaining chapters on Arthropoda, that on the Insecta, though permitting some taxonomic novelties, far surpasses anything previously available.

The first two chapters on Echinoderms are the last of many profound contributions by the late L. Cuénot and deserve the respect due to all his work. The sections on the Crinoidea and Stelleroidea are beautifully fitted to the scale of the "Traité", though the new ordinal and family-group names in the former should not have been proposed here. The chapter on the Echinoidea is scarcely worthy of the rest of the "Traité" or of the tradition of French work in this group. The morphology is inadequately illustrated, and the drawings in the systematic section are clumsy and too often taken from poorly preserved material. The concluding six chapters call for no special comment, though that on the Graptolites seems rather severely compressed.

Each of the first three volumes of the work includes more speculative matter than would a British work of the same kind, and they are not primarily useful as systematic reference books in all groups. They should not be placed in the hands of students without caution. The durability of their value, therefore, rests on a somewhat uncertain basis ; but the standard of morphological and ontogenetic information is high, and it is these introductory sections of each chapter that are likely to prove of most use. Many of the systematic sections are excellent ; but the average level is lowered by a few chapters which weaken the authority of the whole.

R. V. MELVILLE

[1] *Nature*, **172**, 560 (1953).

WILLIAM HERSCHEL : HIS WORK AND PERSONALITY

William Herschel

Explorer of the Heavens. By J. B. Sidgwick. Pp. 228+4 plates. (London : Faber and Faber, Ltd., 1953.) 12*s.* 6*d.* net.

THROUGHOUT the history of astronomy, there are one or two names which stand out in sharp relief when one begins to consider the observational side of the science. Hipparchus, Tycho Brahe and Sir William Herschel are three which immediately come to mind. Each made substantial contributions, and each provided fine sets of observations which were of vital importance to those who followed. But while it is virtually for their observations alone that we remember Hipparchus and Tycho Brahe, William Herschel is noted not only for his outstanding observations but also for the great theoretical use he made of them ; Herschel was, in fact, a great theoretical astronomer as well as the observer *par excellence*.

An able and sympathetic account of this surprising genius is given by Mr. J. B. Sidgwick in this book, in which he concerns himself especially with Herschel the man. He begins, appropriately, with the Herschel family in Hanover, and follows them through their various vicissitudes which finally resulted in William and his elder brother Jacob settling in England. Mr. Sidgwick has a great feeling for his subject ; indeed, we soon find the formal "Herschel" being replaced by the more familiar "William", although a return to "Herschel" occurs when the narrative becomes concerned with his theoretical work. The book usefully brings out the success which attended Herschel's work as a professional musician and gives an admirable picture of the keen amateur astronomer who, in his diary, reported with such obvious relish that ". . . I gave up much time to astronomy and also attended many scholars. Some of them made me

give them astronomical instead of musical lessons". Mr. Sidgwick also gives graphical descriptions of Herschel's labours as a telescope maker and shows how his careful application to this work enabled him to produce instruments of a quality far surpassing anything then available; so good, in fact, that the magnifying powers he was able to use were for a time doubted by his contemporaries.

But it is in William Herschel's prowess and assiduity as an observer that his greatest claim to fame lies; and while it may be felt that Mr. Sidgwick gives more place to biographical details than to Herschel's astronomical work, nevertheless we do obtain a real sense of the perpetual observing which Herschel carried out as well as of the devoted assistance rendered by his sister Caroline. As to Herschel's pioneering endeavours in the theoretical field, in which he drew on his own unique fund of observational material, it is here that the book is not quite so satisfactory, as is to be expected, perhaps, in one written to have so wide an appeal as is clearly Mr. Sidgwick's aim. All in all, however, this volume, written with style and imagination, gives a good portrait of one of astronomy's greatest figures. It is free from any gross errors and, with its short but useful bibliography, is to be recommended.

C. A. Ronan

1950 INTERNATIONAL CONGRESS OF ELECTRON MICROSCOPY

Comptes Rendus du Premier Congrès International de Microscopie Électronique

Paris, 14–22 Septembre 1950. Mémoire hors série No. 1. Publié par la Société Française de Microscopie Théorique et Appliquée avec le concours du Centre National de la Recherche Scientifique. Pp. viii+768. (Paris: Éditions de la Revue d'Optique Théorique et Instrumentale, 1953.) 8000 francs.

THE First International Congress of Electron Microscopy, held in Paris in 1950, attracted such a great number of participants that the report of its proceedings constitutes in itself a survey of the whole subject of electron microscopy as it stood at that time. In a short review it is only possible to indicate its scope. Electron optical theory claims thirty-one papers, but the design and construction of the microscope itself only eight papers; there are twelve on electron diffraction. Metallurgical applications, in eighteen papers, include work on metal physics as well as on more immediately practical problems of both ferrous and non-ferrous metallurgy. Twenty contributions on chemical applications range from pigments and polymers to photographic emulsions and clays. Biological applications not unnaturally attracted most attention, with forty-four papers which dealt with specimen preparation techniques (fixation, drying, sectioning, replicas), on one hand, and on the other with the use of the electron microscope in almost every type of biological and medical problem (viruses, bacteria, cancer, nerve, muscle, blood cells, teeth).

In two respects the Congress report is more informative than the meeting itself: first, it was physically impossible to attend all the sessions, and now every paper is available in print; and secondly, a large group of papers from Japan (twenty-four) which were read in title only are now printed in full. Two complaints may be made against the report: it appears almost three years after the meeting, although the manuscripts should have been submitted before the meeting, and the price is high. The explanation in both cases probably goes back to the desire to include every contribution in full. In such a rapidly advancing subject as electron microscopy speed is possibly more important than comprehensiveness in publication.

It should also be mentioned that the Paris Congress was not the first in electron microscopy either *de facto* or *de jure*: the first meeting of the International Commission for Electron Microscopy to be held under the auspices of the International Council of Scientific Unions was held this year in London, and prior to the Paris meeting at least two conferences of an international character had taken place, in Cambridge (1948) and in Delft (1949).

V. E. Cosslett

USE OF DIMENSIONS IN PHYSICS

Dimensional Methods and Their Applications

By Dr. C. M. Focken. Pp. viii+224. (London: Edward Arnold and Co., 1953.) 30*s*. net.

LIKE most of the basic principles of science, the subject of dimensions has grown up rather untidily; it is presented differently and with different conventions in almost every department. The appearance of this book, with its suggestions for standardization and its careful consideration of many of the difficulties involved, is therefore very welcome. If it reads in places somewhat like a tract, this is only because the author wishes to present every side of each problem and yet to make his own firm recommendation about which side to accept.

The subject is covered very well, with ample references and quotations from some of the more important papers. The sections on the dimensions of thermal and electrical and magnetic quantities will be found by most physicists to be extremely helpful.

In such a thorough treatment, it seems strange that the possibility of vector notation has not been considered. This could be very useful; for example, the dimensions of energy and of the moment of a force are both (ML^2T^{-2}); but physically they are quite dissimilar, the former being a scalar and the latter a vector. If a distinction could be made, it would be possible to make use of the result that all terms of an equation should be either scalar or vector, as well as dimensionally similar.

One point with which physicists will be inclined to disagree is the author's rejection of the physical basis of the principle that the argument of a transcendental function (for example, e^x) should be dimensionless. This basis seems so reasonable that the reviewer, at any rate, will continue to make use of it when he has need.

The book is well bound; but the printing is rather displeasing. It appears to be reproduced from electric typewriting; but the spacing of the words and even of the letters is not up to good printing standards, and the right-hand edge of the type is often rather ragged. It is to be hoped that this method of printing books will not be copied until it is a great deal better.

H. Lipson

The Kalahari Sands of the Lunda (N.E. Angola), their Earlier Redistribution and the Sangoan Culture

Companhia de Diamentes de Angola: Museu do Dundo. Subsídios para a História, Arqueologia e Etnografia dos Poros da Lunda. Publicacoes Culturas No. 20. By J. Janmart. Pp. 65. (Lisboa: Companhia de Diamentes de Angola.) n.p.

SENHOR J. JANMART, chief of the prospecting service of the Companhia de Diamantes de Angola, has spent many years in studying the Kalahari Sands and their immediate derivatives. The Sands themselves fall into a threefold chronological series: Lower Kalahari (Kamina formation); Middle Kalahari (silcrete); and Upper Kalahari (Kalahari Sands). All three deposits are pre-Pleistocene in age. Following on the deposition of the Upper Kalahari Sands denudation and redeposition have taken place, and a series of beds of redistributed sands has been determined. The volume under review deals with the first two of these post-Upper Kalahari beds and their correlation with archæological discoveries.

The Upper Kalahari Sands and the earliest of the redistributed sand layers so far have yielded no human artefacts. If the Upper Kalahari Sands are assigned to a late Pliocene date, the succeeding layer may perhaps be considered as early Pleistocene, since the succeeding layer (redistributed sands (II)) contains Sangoan industries. Actually two typical Acheulean coups de poing have been found in a deposit which seems to date immediately anterior to the deposition of the redistributed sands (II), and this is what one would expect since the Sangoan culture is post-Acheulean in date and belongs to the Middle Stone Age complex both in East and South Africa.

This volume under review is an interesting contribution to knowledge and is well illustrated both in the way of half-tones and maps, sections and reproductions of stone implements. Those of us who read Portuguese with some difficulty are grateful to the author for having so considerately written the volume in English.

M. C. BURKITT

Australian and New Zealand Botany

By Prof. J. McLuckie and Dr. H. S. McKee. Pp. xx+758. (Sydney: Associated General Publications, 1954.) £Aust.4 4*s*.

ONE of the problems of teaching elementary botany in the Antipodes is that the text-books are European. The enthusiastic teacher may illustrate his lectures by the use of Australian plants, and he will be obliged to use some local types in the laboratory; but the student will still turn to standard British texts, and will read about fertilization in *Fucus* although he has seen it in *Hormosira*, and about the male cones on *Pinus* although he has dissected them on *Macrozamia*. There has long been need of a text-book up to first-year university standard based on plant life as the Australian student sees it, not as the professor from England remembers it. Drs. McLuckie and McKee have now supplied this need admirably. Their book amply covers a conventional first-year course. It is well illustrated with large numbers of original drawings. There are a full and up-to-date discussion of physiology, and a lucid section on fungi (where most of the types are providentially similar for the English and Australian student); a summary, all too brief, on the Australian and New Zealand flora, containing material which has not been assembled before in accessible form; and finally a brief history of botany in Australia and New Zealand. The book is a credit to Australian publishing, which until recently could not have produced such a book as this. It will undoubtedly be the mainstay of generations of Australian and New Zealand students.

E. A.

Science in Everyday Life

By Ellsworth S. Obourn, Prof. Elwood D. Heiss, and Gaylord C. Montgomery. Pp. viii+612+16 plates. 30*s*. net. Teachers Guide for Science in Everyday Life. Pp. 21. 3*s*. net. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.)

THE book is written for young adolescent boys and girls, and aims at developing an interest in science and an understanding of its applications in solving everyday problems. A very broad field is covered; indeed, the book has something of the character of an encyclopædia; but it is designed as a definite teaching course covering a single school year. The 'topic' method is followed as a means of stressing the unity of science, and emphasis is laid throughout on the underlying theme of energy.

With so wide a range of subject-matter the treatment is perforce very superficial, and from the point of view of general science teaching one feels that the authors have at times tried to build too much on what must necessarily be meagre foundations. For this reason the book would find only very limited application in the classroom in Great Britain, where the tendency is rather to narrow the field and so allow more detailed treatment. It would commend itself rather as a personal reference book for the bright thirteen-year-old child with a scientific bent. As such its appeal is enhanced by the numerous good illustrations and diagrams, also suggestions for experiments or observations drawn from common daily experience.

MAURICE ASHBY

Seventh Congress of the Universities of the Commonwealth, 1953—Report of Proceedings

Edited by Dr. J. F. Foster. Pp. xxxviii+296. (London: Association of Universities of the British Commonwealth, 1954.) 21*s*.

THIS admirably produced report of the proceedings of the Seventh Congress of the Universities of the Commonwealth, 1953, includes the text of the opening addresses at the five main sessions of the Congress and also those given at the two sessions on the special topic of the subject or subjects to-day best fitted to fulfil the part played previously in the university curriculum by the classics, as well as reports of the ensuing discussions. Although there is no index, the layout of the contents is such as to facilitate ready reference to the remarks made by any particular speaker or on any subject discussed. Besides the report of the executive council of the Association of Universities of the British Commonwealth for the period July 1948–June 1953, there are appended a report by the Committee for Commonwealth University Interchange on interchange visits between Commonwealth Universities and a note by the Principal of the University of London on the effect of superannuation schemes on mobility of academic staff within the Commonwealth. The Association is to be congratulated in placing on permanent record so much material of continuing interest in current discussions in a form as pleasant to handle as it is convenient of reference.

THE ROYAL SCOTTISH MUSEUM, EDINBURGH (1854–1954)

By Dr. F. S. WALLIS
City Museum, Bristol

THE centenary of an organization provides a suitable opportunity to indulge in a historical survey and to indicate lines of progress for the future. Dr. D. A. Allan, the director, has developed both these themes in an admirable brochure published to commemorate the centenary of the Royal Scottish Museum in Edinburgh.

In common with the history of the majority of museums, the roots of the idea ante-date the actual foundation. In 1812 there was initiated in the University of Edinburgh a Natural History Museum, which though mainly formed for teaching purposes also served the general public to a limited extent. The collections were chiefly zoological; but a certain amount of the then inevitable ethnological material soon appeared.

The middle years of the nineteenth century witnessed a tremendous interest in industrial processes, and eventually, as a result of strong representations in Parliament, in 1854 a sum of £7,000 was voted for the purchase of a site and initial expenses in connexion with the establishment of an Industrial Museum for Scotland. The site, immediately to the west of the University of Edinburgh, consisted of an open space and two buildings. Dr. George Wilson was appointed the first director in April 1855 and later he received the appointment of professor of technology in the University of Edinburgh. This Industrial Museum of Scotland was really intended to be a museum of the industry of the world in special relation to Scotland. Also in 1855 the Edinburgh Town Council, patrons of the University, voted that the Natural History Museum in the Old College be handed over to the same body—the Department of Science and Art—controlling the new Museum. The foundation stone of the building, designed in Venetian Renaissance style, was laid by the Prince Consort in 1861. The first section was the eastern one, nearest the University, and subsequent additions extended westwards and southwards. On May 19, 1866, the first portion was opened formally by Prince Alfred, Duke of Edinburgh, while the most recent addition was opened in 1938. In 1864, to meet the dual functions demanded by two types of museums, the title was changed to the Edinburgh Museum of Science and Art. In view of the wide educational use made of museums in the present day, it is interesting to note that about this time courses of lectures for artisans were organized in natural history, geology, chemistry and natural philosophy at the modest fee of 1*s.* per course.

In the early days the work of the staff was impeded by almost continuous building operations, and the interest of the public was rather retarded by the discomforts of poor entrances and finally the construction of a street along the Museum frontage. Notwithstanding all this, some large attendance figures are recorded and the staff constructed some pioneer natural history groups, built technological models and prepared three catalogues on mineralogy, geology and British Foraminifera. The Museum also commenced to stage loan exhibitions, beginning with art, needlework and art fans, while one of Indian gifts made to H.R.H. the Prince of Wales brought the attendance in 1879 to 647,294. In 1904 the Museum celebrated its jubilee and its name was changed to the present one of the Royal Scottish Museum. Also in this year the building was refloored with oak, the roofs were reglazed—top lighting is a continual bugbear to administrators—and a new heating and ventilating system installed.

Up to this time the Royal Scottish Museum, in common with similar institutions, acquired its collections by gift, purchase or loan. The choice was thus limited by the likes or dislikes of private collectors. Such a state of affairs made it difficult to build up a systematic, comparative or chronological series, and in 1907 Mr. E. Ward was sent to Egypt to take part in archæological excavations and thus acquire material with adequate data. This policy of selective acquisition was soon extended to other Departments in the Museum. In 1910 a report was made concerning the state of local museums in Scotland. Thus was started that fatherly interest which has been such a feature of Dr. Allan's directorship. His influence on local museums to secure greater efficiency can scarcely be over-estimated. In 1930 "The Exhibit of the Month" was introduced, whereby some notable specimens or a new accession could be brought to the special notice of the public. Even at this period of its existence the need for a lecture theatre was stressed, for public lectures given fortnightly were attracting audiences of about two hundred. The priority of this requirement is still being emphasized by the Standing Commission on Museums and Art Galleries. But with the frequent extensions to the buildings and the consequent reallocation of galleries a certain amount of inevitable confusion had arisen. The evacuation of material necessitated by the Second World War gave the opportunity in 1946 for a re-arrangement on simpler lines. Natural history and geology now occupy the eastern block, art and ethnography the centre, and technology the western block. The administrative offices and laboratories are situated in the rear, while the reserve collections are housed in the basement and in one special block. The post-war reorganization also permitted of new schemes of redecoration, and for the first time a complete scheme of colours for walls, staircases, passages and case framings was drawn up with the aim of securing a harmonious background against which the exhibits would be accentuated. The Museum is now administered by the Scottish Education Department at a cost of about £75,000 per year.

The record of achievement concludes with short histories by the keepers of the separate Departments. Mr. Robert Kerr, keeper of the Department of Art and Ethnography, points out that though the original collections were associated with the early Industrial Museum, it was not until 1901 that the present departmental nomenclature was adopted and the acquisitions became more and more associated with the arts—not the graphic ones—and craftsmanship. They include metalwork, ceramics and glass, ivories, furniture and woodwork and textiles. The Main Hall

and large hall beyond provide a display of specimens illustrating European art, Oriental art, primitive art and the civilization of Ancient Egypt. On the first floor are the main comparative series of ceramics, arms, coins, glass and medals. The silver is notable for some excellent Scottish examples. The Textile Gallery shows a representative collection of lace, Persian and Oriental embroideries and early pieces from Egypt and Peru. Upstairs, on the second floor, are galleries illustrative of comparative ethnography, with some outstanding Japanese prehistoric material.

Dr. A. C. Stephen stresses the association of the early natural history specimens with Prof. Robert Jameson, that outstanding personality who inspired so many Scots to collect in foreign lands. The exhibition galleries comprise fourteen rooms in the eastern half of the building and includes sections devoted to British and foreign birds, British mammals, extinct animals, beasts of prey, large ungulates, proboscideans, reptiles, fish and a recently arranged insect display. The Children's Gallery, with a fine diorama of the foreshore facing Bass Rock, is a striking feature. Mention must also be made of the Type Gallery and the Hall of Comparative Osteology, designed chiefly to meet the needs of students as distinct from members of the general public. The technical equipment of this Department is remarkably complete, and includes two studios for the skinning and mounting of animals, a large de-greasing plant and recently a freezing apparatus is being installed in the basement. The subject of botany is, of course, dealt with in the Royal Botanic Gardens.

Mr. A. R. Hutchieson, keeper, in describing the Department of Technology, naturally refers to the fact that it had its beginnings in the Industrial Museum of Scotland, and even some of its collections go back to the material acquired from world-wide sources following the Great Exhibition of 1851. These are augmented by industrial models and scientific apparatus derived from the Royal Scottish Society of Arts, the Royal Highland and Agricultural Society of Scotland and the University of Edinburgh. As early as 1866 a technological workshop was started in the Museum, and this in recent years has produced some amazingly accurate models, notably one of the Temple bascule bridge, Glasgow, complete with traffic controls, and equipped with a talking label, employing wire recording apparatus. In both World Wars the workshop became a small production unit for national purposes. The collections are housed in six galleries, devoted to power, shipping, mining and metallurgy, navigation and science. Adjacent to the Science Gallery is the Radiation Gallery, in which is a series of exhibits operable by the visitor and showing the properties of a variety of rays.

Dr. C. D. Waterson, assistant keeper in the Department of Geology, refers with natural pride to the historic nature of the collection under his care. They recall the great Wernerian–Huttonian controversy, the exploration of the North-West Passage, and the hobby of Hugh Miller, the stonemason. In common with the other Departments, the return of the material after evacuation for the War gave the opportunity for entirely new display methods in the four galleries at the east end of the top floor. The recent publication of a Catalogue of Fossil Fish recalls the name of Dr. R. H. Traquair, of international repute, who was at one time keeper of the Department of Natural History.

In a closing section, Dr. Allan rightly recalls that centuries are more than end-points, for they are starting-points for a new period of endeavour. With other museums now in the City of Edinburgh, the Royal Scottish Museum still has as its main function the collecting, conservation, display and interpretation of material in art, ethnography, natural history with geology, physical sciences and technology. World-wide exhibits are used where necessary, and Scottish ones where possible.

It only remains to state that the format of this brochure is very attractive. Illustrated with half-tone blocks and plans, it gives a visual impression of the buildings at various stages of their development, and a genealogical diagram portrays clearly the composition of the present staff and their inter-relationships.

It is written and edited in that individualistic, factual but stimulating style which we now associate with the pen of Dr. D. A. Allan, and is not only interesting as a record of achievement in Edinburgh but also recapitulates faithfully much of the history of the museum movement in Great Britain.

THE MUSEUMS ASSOCIATION

THE sixtieth annual conference of the Museums Association was held amidst the capital splendour and beauty of Edinburgh during July 19–23, under the presidency of Sir Leigh Ashton, director of the Victoria and Albert Museum, London.

The conference coincided with the centenary of the Royal Scottish Museum, and members were privileged to attend the ceremony on this historic occasion and share in the greetings offered by distinguished guests. The Minister of State, the Right Hon. the Earl of Home, presided, and felicitations were expressed by those representing the City, the University and museums at home and abroad. Dr. Douglas A. Allan, director, replied and paid a warm tribute to the Ministry of Works and other colleagues who had brought the Royal Scottish Museum to its present high standard of display.

This year no overall theme was selected for the conference; but the individual papers were of a high level, and the discussions were stimulating and of interest both to the professional members and institutional delegates. Sir Leigh Ashton, in his presidential address on "The Functions of Museums", stressed the importance of conservation and enumerated the other functions as assistance given to the scholar, the child and the general public. He paid tribute to the Carnegie United Kingdom Trustees for their welcome help to the museum movement and the influence of their grants for improved presentation, and stressed the importance of imagination in dealing with the educational side of museums.

Mr. Ritchie Calder, in a paper on "Museums: our Wasting Heritage", felt that an artificial culture was replacing real values. He appealed to the museum profession to help in the preservation of our heritage and felt that they could study with advantage much of the publicity methods of the commercial world.

Dr. D. E. Owen (Leeds), speaking on "Making Friends for the Museum", considered that the needs of the museum were different from those of the art gallery. The former required workers both for the acquisition and identification of material, while the latter were in need of patrons to lend, give or buy works of art. A museum of archæology probably required both types. He considered that much help

could be given to folk museums by systematic circularization of those in close touch with the countryside.

For the first time in the history of the Association and as an experiment a session was given to sectional meetings. In that devoted to archæology, ethnography and folk-life, Dr. D. B. Harden was chairman, and Mr. R. J. C. Atkinson gave a paper on "A National Index of Archæological Collections". Mr. Atkinson sought the co-operation of museums in the compilation of illustrated indexes of British archæological objects: (1) Inventaria Archæologica of associated groups chiefly of the 2nd millennium B.C.—an international project of which some Belgian and German cards are published; (2) British Association card index of bronze implements, formerly in the British Museum, now at Oxford, in abeyance since 1939; (3) Corpus of Bronze Age pottery, being organized by the Council for British Archæology; and (4) School of Scottish Studies, Edinburgh, neolithic and bronze age indexes. Mr. F. G. G. Carr (National Maritime Museum) and Miss Elspeth M. Gallic (Old Glasgow Museum) then dealt with the difficult problem of the purposeful display of personalia and historical relics. Both speakers stressed the need for proving the authenticity of personalia and historical relics and, if possible, for exhibiting them as part of a well-defined and general pattern. An endeavour must be made to re-create the person to the visitor.

In the section dealing with art and applied art, the president took the chair, and the first discussion was opened by Prof. A. F. Blunt, of the Courtauld Institute of Art, whose subject was "The Teaching of Art History, and the Museum Profession". He described the training in the history of European art provided at the Courtauld Institute. The Institute could not, he stressed, give instruction in the administrative and technical aspects of museum work—this came only with experience and specialized training; but it did provide education of a high standard of great value to entrants to the museum profession.

The other speaker was Miss Helen Gluck, who discussed "The Dilemma of the Painter and Conservator in the Synthetic Age". She showed how, since the commercial introduction of packaged paints, the quality of artist's materials had deteriorated. The situation had become worse since the introduction by the colourmen of synthetic materials. If the paintings of to-day were to survive, the most thorough investigation was required, and a centre, which would make it its business to see that standards were maintained, should be established. Miss Gluck's paper was the subject of lively discussion and the meeting agreed to recommend to the Ministry of Education, as the body responsible for most of the schools of art, that this matter be given serious attention.

The third section, under the chairmanship of Dr. W. E. Swinton, discussed two difficult but important fields for museum treatment. Mr. D. Chilton (Science Museum) defined the essentials of display for meteorology, which is becoming increasingly of public interest, recommending the exhibition of the standard instruments, in use, if possible, and a selection of cloud photographs. Dr. John Burton (medical director of the Central Council for Health Education) stressed the ways in which the local museum could play its part in the hygiene campaign and discussed the kinds of travelling exhibitions which were and could be prepared, and the part that the local medical officer of health could, and probably would, play in co-operation with the museum.

Dr. F. J. North, chairman of the Education Committee, opened a discussion on training problems in the museum profession. After referring to the difficulties of the task and its consequent challenge, he said that it should be possible to induce at least one university to establish a department of museology, or better still, to create conditions in which the Association could have its own training institution. Subsequent speakers stressed that such a training should be in the nature of a postgraduate diploma course. The training needs of museum curators fall into two categories. First, instruction in some museum subject generally received in a university or equivalent institution, and secondly, the application of that knowledge to the needs of a museum. As matters are at present, training in the latter part can only be given in museums and several trainee-assistant schemes are in operation. Dr. North naturally summarized the diploma scheme of the Museums Association for curators and the more recently instituted technical certificate. Opportunity was taken at the end of the discussion to express the gratitude of the Association for his great services during his eight years chairmanship of the Education Committee and for his pioneer work with regard to the establishment of the diploma and technical certificate.

The hospitality of Edinburgh was extended to members by receptions at the Assembly Rooms, the Royal Scottish Museum and the Scottish United Services Museum, and the Association was honoured by the presence of the Lord Provost and other distinguished citizens at its annual dinner. Tours to Loch Lomond and the Loch Sloy scheme, Haddington and East Lothian and the Border Abbeys closed a stimulating week.

At the annual meeting of the Association, Sir Leigh Ashton was re-elected president, and Mr. E. C. Chubb, director of the Durban Museum and Art Gallery during 1910–51, was elected an honorary fellow. It was decided to hold the next conference at Birmingham during July 4–8, 1955.

THE UPPER ATMOSPHERE

As part of its summer meeting in the University of Edinburgh during July 15–17, the Royal Meteorological Society held a symposium on "The Upper Atmosphere". Dr. O. G. Sutton, president of the Society and director of the Meteorological Office, presided.

The first speaker at the symposium was Sir Edward Appleton, principal of the University, who began by emphasizing the remarkable complexity of the structure of the upper atmosphere and proceeded to give a survey of the present state of our knowledge of the subject, indicating the regions that are the seats of the various phenomena which were to be discussed by subsequent speakers in the symposium. He likened the upper atmosphere to a vast laboratory in which the sun daily actuates a series of experiments at low pressures, in conditions and on a scale which we cannot hope to reproduce experimentally. Solar ultra-violet radiation creates, at different levels, the ozonosphere and the ionosphere by dissociating molecules and by ionizing both atoms and molecules. Further, the gravitational attraction of the sun and moon causes marked atmospheric tides at high

levels, and the influence of the earth's magnetic field comes into action as soon as any charged atmospheric particle begins to move. Meteors, sporadic and in showers, produce streaks of ionization which can be observed by eye if clouds are absent and always—even in Manchester—by radio. It may be that fine meteoric dust forms a permanent part of the ionosphere.

Sir Edward then discussed some ionospheric problems which he and his research assistants in Edinburgh, Mrs. Pritchard and A. J. Lyon, have recently examined. "If the nature of your occupation prevents you from doing any experiments, it need not prevent you from thinking—thinking about other people's measurements." In the field of geophysics, many people are engaged in making measurements, but he sometimes wondered whether enough people are thinking about what these measurements mean, when they are compared with one another. He and his assistants have been examining measurements of ionization densities in the layers of the ionosphere from a world point of view by using the observations of ionospheric stations operating in different parts of the world.

Examining first the world morphology of the $F2$ layer, they investigated the variation of $fF2$ at noon at the equinoxes with both geographical and geomagnetic latitude and have found the closer fit with the latter. The curve shows a trough in the region of the equator, where $fF2$ is a minimum. When curves are drawn for other times of the day, it is found that in the late evening hours the trough becomes a crest. No such effect appears in similar curves drawn for the E and $F1$ layers. This difference between the $F2$ layer and the lower E and $F1$ layers is not thought to indicate that the $F2$ layer is caused by electrified corpuscles. They think that ultra-violet radiation, certainly the cause of the E and $F1$ layers, is also responsible for the $F2$ layer and that the effect is due to geomagnetic distortion. The movements associated with the diurnal oscillation, tidal or thermal in origin, which these observations disclose, would be subject to strong control by the geomagnetic field at the low densities obtaining at the $F2$ level. But, though theories have been proposed by Martyn, Maeda and Weiss, there is as yet no satisfactory theoretical explanation. The investigation of the $F2$ layer by Sir Edward and his co-workers has further revealed that, during an ionospheric storm, the value of noon $fF2$ is reduced in high latitudes and increased at the equator.

While their examination of the world morphology of the E and $F1$ layers has shown no strikingly abnormal effects, even here there are small departures from simple theory. It was well worth while investigating such discrepancies, for there is always the possibility that the investigation may yield a method of measuring the magnitude of the factor which itself causes the discrepancy. In illustration, Sir Edward then considered some features of the E layer, and from the continuity equation showed that, in an ionized medium:

$$N = \sqrt{\frac{q_0 \cos \chi}{\alpha}},$$

where N is the ion (or electron) concentration, χ the zenith distance of the sun and α the coefficient of recombination. If q_0 and α are constant, then N is uniquely determined by $\cos \chi$. A curve showing the annual variation of N_E for constant χ may be drawn using experimental data, since χ is the same at noon in winter and in the early morning or late evening in summer. They have found, in fact, that N_E for constant χ has a minimum in June, so that either q_0 or α, or both, varies; conditions are not the same in summer and winter at the same height.

Finally, Sir Edward discussed the methods they are using in their attempt to determine accurate values of the recombination coefficient at low pressures at all times of the day throughout the year and showed how the coefficient may be determined from observation of the time-lag between the maximum of the ionizing process (at noon) and the ionization maximum; values of the order of 10^{-9} and 10^{-8} have been obtained. They have taken the opportunity, afforded by the recent eclipse, of making such measurements at a minimum of solar influence; Mr. Lyon has successfully made radio observations on the ionosphere at Slough, and they are at present engaged on working out the results.

By studying the reflexion of radio waves from the trail of ionized air produced by a meteor, the atmosphere at heights between about 85 and 105 km. may be sampled, simply and at low cost, several hundred times per hour throughout the day. Dr. Ian C. Browne summarized the results obtained by many workers using this method at Jodrell Bank, University of Manchester, since 1946. Measurements of air density and of scale height (about 3×10^{-9} gm. per c.c. and 6·5 km. respectively at 95 km.) may be obtained from observations of the intensities and heights of appearance of meteor echoes, and the atmospheric diffusion coefficient may be calculated from the time of duration of the echoes. In addition, movements of meteor trails of the order of one metre may be detected by using a special technique, so permitting the measurement of wind speed at the height of the trail, for 'meteor winds', in contrast to those obtained by ionospheric methods, are true mass movements of the air. Superimposed on a prevailing wind of about 10 m./sec., there is a semidiurnal component which may have an amplitude of 30 m./sec.; the phase and amplitude of this semidiurnal component show seasonal changes. The winds increase with height, the value of the shear being about 2×10^{-3} per sec., that is, roughly the same as in the troposphere; but there is no change in wind direction with height and no detectable vertical component. Dr. O. G. Sutton asked if Dr. Browne could suggest a mechanism which would account for the maintenance at such great heights of such a regular shear. Dr. Browne was of the opinion that the explanation lies in the temperature distribution at these levels. Dr. T. W. Wormell doubted if the motion of an ionized meteor trail is identical in magnitude and direction with the general air-motion at the same level; he questioned if we could neglect completely the effect of magnetic forces on the moving ions and electrons.

Dr. H. P. Palmer summarized the work at Jodrell Bank on the fluctuations of the power received from the intense sources of radio emission in Cassiopæia and Cygnus. The facts that the fluctuations occur mainly during the night and that the degree of fluctuation varies from night to night, showing a close correlation with the occurrence of 'spread F' ionospheric echoes, indicate that the cause is a terrestrial agency, which is thought to be a diffracting screen of irregularities above the maximum of ionization in the F region. Small time-differences, which are detectable when records from receivers 2–3 km. apart are compared, are interpreted as

evidence of drift motions of the diffracting screen. Drift speeds of 50–300 m./sec. in an east–west direction have recently been determined from approximately vertical observations from three stations. During the months December–April, when these stars transit near midnight, the drift is found to be easterly until 01 hr., U.T., then to reverse sharply and to remain westerly thereafter. When the stars are observed at lower culminations, the line of sight traverses the *F* region in the auroral zone, and fluctuations are then observed at all times, even on magnetically quiet days. Drifts now observed are of greater magnitude and more variable direction, predominantly towards the east during the period 19–21 hr., and towards the north-east or north-west during 21–06 hr.; but it may be that the apparent north–south components arise from vertical motions.

During an investigation into methods of representing the wind field at the 100-mb. pressure-level, it was found that winds observed at this level from British upper-air stations show diurnal and semi-diurnal variations. D. H. Johnson, of the Napier Shaw Laboratory, Meteorological Office, Dunstable, gave an account of an analysis he has made of these solar tides in the lower stratosphere. He pointed out that observations at the 100-mb. level are particularly suitable for this study since the lower stratosphere is relatively free from effects that might mask the tides; synoptic variations of wind, for example, are small. Using observations made by radar and radio direction-finding techniques, he computed the deviations of the annual mean south- and west-wind components at three-hourly intervals from the respective overall annual mean wind components and found expressions for the annual mean oscillation of each component by harmonic analysis. He found that the stratospheric oscillation is approximately in phase with the surface wind oscillation derived theoretically by Bartels from Simpson's expression for the semidiurnal variation of surface pressure, a result in accordance with tidal theory. The amplitudes of the south and west wind-component oscillations at the 100-mb. level are 0·67 and 0·51 knots, respectively. The corresponding values derived by Bartels for the surface wind-component oscillations are 0·87 and 0·85 knots, respectively [see also p. 363].

D. H. McIntosh, superintendent of Eskdalemuir Observatory, discussed the possibility of determining winds at ionospheric levels from geomagnetic observations. He outlined the development of theoretical work on the problem of the interpretation of geomagnetic observations since Balfour Stewart suggested in 1882 that the upper atmosphere is highly conducting and that its daily horizontal tidal movement across the vertical component of the earth's field induces currents, the magnetic field of which is observed at the ground as the magnetic daily variation. Schuster, and later Chapman, have developed the theory of the magnetic solar daily variation and of the corresponding lunar effect. While many problems remain unresolved, the theory in its fundamentals has received striking confirmation in several ways, initially by the experimental discovery of the ionosphere and most recently by the discovery by a rocket ascent of a discontinuity of the geomagnetic field at about 100 km., revealing the presence there of a current sheet. So, the dynamo theory of the daily magnetic variation implies that any mass movement of air at ionospheric levels must register in the magnetic records. Wulf has recently examined the problem of determining ionospheric winds in this way, but success has been limited. Vestine, on rather debatable assumptions, has derived wind systems compatible with the annual variation of magnetic disturbance and with the features shown by a particular magnetic storm. Mr. McIntosh was confident that, with the prospect of obtaining direct measurements of ionospheric winds by means of the newly developed radar-sonde, important progress with this problem is likely in the near future.

A paper by Dr. A. H. Jarrett, of the University of St. Andrews, on the possibilities of multilayer coatings for auroral research was read by J. Paton, University of Edinburgh, Dr. Jarrett having been detained after his eclipse observations in Sweden longer than anticipated. Examination of the spectrum of auroræ provides a method of estimating temperature at auroral levels; but, because of the low dispersion of auroral spectrographs and of the long exposures necessary with an extended source like the aurora, measurements are difficult and results uncertain. The use of multilayer coatings in place of the usual silver films in the interferometer considerably reduces absorption and so the times of exposure. With exposures as short as twenty minutes, Dr. Jarrett has recorded Fabry–Perot fringes from auroræ using the 5577 A. line, by placing the interferometer in front of the *f*/2 Summar 5-cm. focal length camera lens. This preliminary investigation indicates the great possibilities of the use of multilayer coatings in auroral spectroscopy. The United States National Committee for the International Geophysical Year has generously proposed to lend to the British Committee the latest type of auroral spectrograph, working at *f*/0·8 with a dispersion of 25 A./mm. This instrument will be installed at St. Andrews Observatory and will make possible the first British measurements of temperature from auroral spectra. Dr. Jarrett hopes to equip the instrument with a photoelectric scanning arrangement for direct recording.

Brilliant displays of the rare noctilucent clouds have recently been seen from central Scotland, and their height, position and speed have been determined from parallactic photographs. Mr. Paton discussed the importance of observations of these clouds in providing information concerning the physical state of the upper atmosphere at the height of about 80 km. at which they invariably occur. Besides yielding direct measurements of wind, they indicate the existence of a temperature minimum at 80 km. Wind speeds of the order of 50 m./sec. have been measured; Störmer has recorded speeds of more than 100 m./sec., and Jesse of about 300 m./sec. On every occasion when the clouds have been observed from Scotland, this movement has been from the east-north-east. But, since they are made visible by the sunlight scattered by the material of which they are composed, they are observed only on nights when the sun remains close below the horizon—that is, during the summer months in middle latitudes. Presumably they may be present at other times and in other latitudes, but they will not remain sunlit long enough to be observed. Their nature is still in doubt, though their tendency to appear at times of comet and meteor occurrences strongly supports the belief that they consist of meteoric dust. E. G. Bowen has recently pointed out that they appear either on or very near the dates of the daylight meteor streams discovered at Jodrell Bank, but Scottish observations show no such tendency. On one occasion, a portion of the clouds was observed to

change colour from vivid blue to white, suggesting growth of the cloud particles by condensation. When opportunity offers, the new spectrograph at St. Andrews will be employed to investigate such changes in the spectrum. Finally, slides were shown illustrating a remarkably sudden change from their characteristically stable structure to quite chaotic shapes that occurred in the early morning of July 25, 1950. Noctilucent clouds have been observed on twenty-two nights since 1939; but this was the only occasion when turbulence was seen. It may be significant that it was also the only occasion when aurora occurred simultaneously with the noctilucent clouds.

OBITUARIES

Prof. J. T. Hewitt, O.B.E., F.R.S.

Prof. J. T. Hewitt, while crossing the road near his home at Hurst, Berkshire, on July 9, was knocked down and killed by a motor-car. Although he was eighty-five years of age, he was still active, and his death came as a shock to all who knew him. He was born at Windsor in 1868. After an unconventional schooling, he went to the Hartley Institute (now the University of Southampton) and at sixteen was a student at the Normal School of Science (later the Royal College of Science). At eighteen he was a scholar of St. John's College, Cambridge. He took the Normal School associateship in 1887, and three years later had a first in both parts of the Natural Sciences Tripos and a first in the London Honours B.Sc. Before 1893 was out, he had worked in Heidelberg and in Berlin and had acquired the Ph.D. (Heidelberg) and the D.Sc. (London). He was appointed professor at the People's Palace Technical Schools at Easter 1894, at the age of twenty-five. In the next twenty years, during which the Schools had emerged as a school of the University of London under the title of East London College (now Queen Mary College), he had as students or research students many men who later rose to important academic, governmental or industrial posts. To make a selection is always invidious, but the following names might be mentioned to show the range of interests involved: H. A. Phillips, A. E. Pitt, T. S. Moore, A. E. Dunstan, J. J. Fox, J. Kenner, G. M. Bennett, J. C. Drummond, A. D. Mitchell, T. F. Winmill and W. G. Hiscock.

Hewitt, F. G. Pope and Clarence Smith shared the lecturing at East London; Hewitt gave the intermediate inorganic lectures, which were first class and very well illustrated by experiments, and all the general and honours lectures on inorganic and on physical chemistry. He also attempted to teach his students some mathematics. What was so attractive about Hewitt's lectures was his unconcealed interest in any and every branch of chemistry: in dealing with sodium thiosulphate he could not keep out Bernthsen's methylene blue synthesis, nor Willgerodt and Mascarelli when he was talking about iodine. To him, metallurgical processes, the phase rule, and the determination of accurate atomic weights were all intellectually diverting.

When Hewitt was elected into the Royal Society in 1910, he had an international reputation as an authority on the relation between colour and constitution. He had original views on fluorescence, on the connexion between depth of colour and degree of conjugation, on the constitution of phenthiazine and safranine dyes and on other subjects. Any student in his department who showed ability and enthusiasm was encouraged by Hewitt to get through the routine analytical course as quickly as possible and start some research.

Hewitt wrote an excellent practical book, "Organic Chemical Manipulations", which was unfortunately allowed to get out of print. He invented a process for the quick maturing of whisky and was consulted by the French wine trade. He played an important part in the famous aspirin law case which was lost by the Bayer group.

During the First World War, Hewitt first worked out processes for manufacturing acetic anhydride and for converting benzene–xylene mixtures into toluene. In 1915 he was commissioned as major and went to the Dardanelles, where he was concerned with such diverse matters as water analysis and cylinders of chlorine. Early in 1916 he returned to England and was seconded to the Department of Explosives Supply. He controlled a small factory at Chiswick, with Clarence Smith as a colleague. They dealt first with explosives and later with materials for chemical warfare. Hewitt was a great admirer of his 'chief', Lord Moulton.

Hewitt resigned from his chair at the end of the First World War and in 1919 joined with T. D. Morson, C. S. Roy, Clarence Smith, J. L. Baker and Miss Hewitt (his much beloved sister) to manufacture fine chemicals (quinine ethyl carbonate, quinoline, methylquinolines, benzthiazole, phenylhydrazine, phenylmethylpyrazolone, etc.). This concern gradually decayed for one reason or another, and the Hewitts left it during 1940. Miss Hewitt died in 1943 and thereafter Hewitt lived alone in his cottage at Hurst. He often went to London, to the Chemical Society and to meetings of the University Board of Studies, of which he was an original member (1901). He was one of the first Fellows of Queen Mary College.

Hewitt was a good chemist, a very human personality and (there is no other word) a gentleman. He enjoyed his life and his memories. It was always a pleasure to see him enter a room full of people he knew: that characteristic, half-courtly salutation—the irresistible charm of a man who lived and worked with zest.

E. E. Turner

Prof. H. Frankfort

Henri Frankfort's most outstanding achievement was to have appreciated and by practical example to have taught others to appreciate the value of archæological evidence as a source of human history. His first work—the two volumes of "Studies in the Early Pottery of the Near East"—was not only an original and pioneer comparison of the then available archæological material from predynastic Egypt, prehistoric Mesopotamia and pre-Hellenic Greece, which despite the unpredictable results of many subsequent excavations still provides the accepted guiding lines for the interpretation of Egyptian prehistory. But his "Studies" also eloquently demonstrated how a detailed objective analysis of ceramic techniques, decorative motives and art styles might disclose a history of very much the same sort as that extracted by philologists from orthodox written sources. Frankfort had been trained in the rigorously literary disciplines of the Classics and Egyptology as taught in Holland during

the 'twenties. But coming as a postgraduate to University College, London, he fell under the spell of Petrie and imbibed something of his flair for the humanist value of material objects made by man. This combination found original expression in the "Studies" and developed ever more fruitfully in his maturer works: for these remained works of scholarship and interpretation.

Of course, Frankfort was no armchair archæologist—he could never have been a great interpreter had he been that. He gained field experience and added to human knowledge first in directing the Egypt Exploration Society's excavations at Tell el-Amarna and then as field director of the Iraq Expedition of the Oriental Institute of the University of Chicago. The latter post gave not only opportunities of studying the monuments in their proper setting but also of organizing a scientific expedition on a lavish scale. The scientific value of the results obtained at Tell Asmer and Khafaje are essentially the fruits of Frankfort's success as its organizer. For though the expedition did uncover some spectacular objects—hoards of early Sumerian statues, for example—it was the (in Mesopotamia) unprecedented thoroughness and accuracy of the planning, recording and conserving of all finds that have invested the latter with unique historical significance. The publication, still far from complete, had been planned by Frankfort, and his own personal contributions—two volumes devoted to the Sumerian statuary—disclose his sensibility as an art critic and vigour in interpretation.

Still, it is in more comprehensive syntheses, written while he was professor in Chicago and later director of the Warburg Institute in the University of London, that Frankfort's genius found fullest expression. In "Kingship and the Gods", and perhaps still more in the introduction and conclusion (written in collaboration with his first wife) to "An Essay on Speculative Thought in the Ancient Near East", entitled in Great Britain "Before Philosophy" and in the United States. "The Intellectual Adventure of Ancient Man", the reader can see how successfully and naturally an archæologist can assume the role of philosopher and sociologist. V. G. Childe

Dr. Henri Mineur

With the untimely death of Henri Mineur, which occurred after a short illness in Paris on May 7, France has lost one of her most distinguished astronomers, and the Paris Observatory one of the best-known members of its staff.

Henri Mineur was born at Lille in 1899. Entering the army at the age of eighteen, he served for a few months with the Engineers and was demobilized with the rank of second lieutenant. Completing his interrupted education at the École Polytechnique, he graduated in 1921 and took his doctorate in mathematical sciences in 1924. At this stage he decided to make his career in astronomy and accepted a post as assistant astronomer at the Paris Observatory in 1925. Within eleven years of work at the Observatory, he had made such a name for himself that he was appointed, at the age of thirty-seven, as the first director of the newly established Institut d'Astrophysique. Work at the Institute had not got into full swing when, at the outbreak of the Second World War, it was virtually suspended, and he became director of a mathematical laboratory devoted to the solution of defence problems. Enlisting in the Armed Forces in 1940, he was appointed professor at the school of military engineering at Versailles shortly before the fall of France. Demobilized in August 1940, he joined the resistance movement and was dismissed from his official posts by the Vichy Government in 1941. Three years later he was reinstated by the new French Government and served for a short while as captain in an anti-tank unit. Again demobilized in 1946, he turned his energies once more to astronomy, and by the date of his death had re-established the Institut d'Astrophysique as a national postgraduate centre for theoretical and observational attacks on current problems on the frontiers of astrophysics.

Mineur's personal researches covered a wide field in celestial mechanics, pure mathematics, relativity theory and statistics as well as in astronomy. He will perhaps be best remembered for his work on differential galactic rotation, carried out independently of Oort's, but leading by somewhat different methods to substantially the same conclusions, namely, that the Galaxy is rotating about a centre some 8,000 parsecs distant towards galactic longitude 325°, at a rate giving one complete turn in 250 million years in the solar neighbourhood. To his credit are also a number of allied investigations into the equilibrium of open galactic clusters, the time-scale of the universe, and absorption of light in interstellar space. His early training as an observer in the Paris Observatory, and, later, his everyday contact with practising astronomers working in the Institut d'Astrophysique under his general direction, combined to confer on his theoretical work a practical insight which lent increased authority to his results.

M. Mineur was awarded the Damoiseau Prize of the Paris Academy of Sciences in 1944 and the Montyon Prize in 1950. He was created Chevalier of the Légion d'Honneur in 1949. A. Hunter

Dr. Loyd A. Jones

Dr. Loyd A. Jones, who died unexpectedly on May 15 at his home in Rochester, New York, a fortnight after his retirement, was well known for his scientific work in photography. He was born in Nebraska in 1884 and, after graduating in the University of Nebraska, was for two years assistant in the Physics Department of that University, assistant physicist at the U.S. National Bureau of Standards for another two years and then joined the Research Laboratories, Eastman Kodak Company, when they were formed in 1912. He soon became chief physicist and head of the Physics Division.

From then onwards Jones's interests were almost exclusively his work on photography and on scientific committees, and his home and garden. He graduated as an electrical engineer, and something of the qualities of an engineer are to be found in much of his published work. This amounts to about eighty papers. His early work was mainly concerned with the measurement of the properties of photographic materials, the provision of instruments for doing so, and related subjects. The major interest was in sensitometry—the measurement of speed and contrast—and tone-reproduction. The culmination of this work was the paper of 1939, "The Evaluation of Negative Film Speeds in Terms of Print Quality", wherein the criterion of correct exposure of the negative was whether the negative gave as good a

print as could be obtained from that negative material whatever the exposure. The quality of the prints was estimated by purely visual judgment, without reference to any physical measurements. The process sounds, and indeed was, laborious; but something of the kind is inevitable, and in Loyd A. Jones's hands it led to a physical measurement which correlated well with the observed speed. This way of measuring speed was adopted by the American Standards Association and the British Standards Institution. The same characteristic approach is to be found in his later papers, on graininess and granularity, and on sharpness, wherein the main effort is directed to the discovery of a purely physical measurement which correlates well with some visual estimate.

Loyd A. Jones served on many scientific bodies, notably on the Colorimetry Committee of the Optical Society of America and the sectional committee on photography of the American Standards Association, for many years. Besides the recognition which he received from scientific and photographic societies in the United States, the Royal Photographic Society of Great Britain awarded him its Progress Medal, the Hurter and Driffield Medal and an honorary fellowship. He leaves a wife and many friends to regret his death so soon after retirement. E. R. DAVIES

Mr. Hugh Griffiths

THE chemical engineering profession has lost a doughty fighter in Hugh Griffiths, who died on June 26, 1954. He was born at Middlesbrough on July 28, 1891, and a very strong influence on his career was his contact there with A. F. van der Heyden, who laid the foundation of his love for mathematics. He took his A.R.C.Sc. in chemistry and was for the most part of his life in consulting practice. His command of the German language and his contacts on the Continent proved most valuable in this connexion.

In 1945 he was elected president of the Institution of Chemical Engineers. As a biography is contained in the *Transactions* for that year, it is now opportune to try to assess his outstanding contribution to the profession. This was undoubtedly his advocacy of the use of the 'Home Paper' as a part qualification for associate membership. He came into the chemical engineering profession as a young man with the practical heritage of the Victorian period behind him. First and foremost with him was the essential engineering background—the need for a practical estimate of the magnitude of the problem and the sizes involved. It was his mathematical and scientific training which then enabled him to apply fundamental conceptions to rule-of-thumb methods, and to develop processes in a manner not dreamt of by his forbears.

His philosophy in supporting the use of the 'Home Paper' for examination purposes was the realization that, if a student is faced with a problem such as, for example, the design of a plant required for the manufacture of 10 tons a day of mono-nitrotoluene, it brings out all that is latent within him and automatically poses to him all the problems which a chemical engineer has to face to be successful. His fierce advocacy of the use of this method of training did sometimes bring him into conflict with his colleagues, as he was always afraid that modifications might result in a lowering of his high standards.

It was in keeping with Griffiths's love of his profession and its heritage that his last public appearance was at Mr. Norman Swindin's lecture in Manchester on the life of that grand old man and founder of chemical engineering, George E. Davis. It was then only too apparent to his colleagues that his life was on the ebb tide. In him they have lost a good friend, and the profession has lost a notable servant.

M. B. DONALD

NEWS and VIEWS

Agricultural Physiology at Cambridge: Dr. John Hammond, F.R.S.

DR. JOHN HAMMOND, who on September 30 retires from his post as reader in agricultural physiology in the University of Cambridge and his honorary directorship of the Agricultural Research Council Unit of Animal Reproduction, has brought an immense amount of prestige to British agricultural science. While his contribution to fundamental research is widely appreciated, it will be as the prophet—in the proper sense of the word—of the physiology of reproduction that his name will be honoured. Son of a Norfolk farmer and nephew of a veterinary surgeon, he absorbed as a student the teaching of the late Dr. F. H. A. Marshall on the pure physiology of reproduction. The significance of his life's work is that, at a time when animal production was under the influence of pedigree breeders and the auction mart, on one hand, and the pathological outlook of the veterinary profession on the other, he brought to its development a more positive scientific approach. The essence of his teaching was the extent to which production could be increased by studying the normal physiology of farm animals and not merely by removing the adverse effects of disease and abnormal physiology. Further, and this may yet be his greatest monument, Dr. Hammond has enthused a large and influential band of disciples, not only within the British Commonwealth but also throughout the world, to initiate research themselves and apply the newer knowledge to the farming industry. Among a wide range of subjects on which he has worked must be mentioned the reproduction and milk production of the cow, which provided the basis of the artificial insemination movement in Britain, and his study of the effect of nutrition and environment on the growth and conformation of sheep and pigs. If the study of animal husbandry ever becomes a profession independent of either agriculture or veterinary science, it will be largely due to the pioneer work and inspiration of John Hammond.

Registrar of Trade Marks in India: Dr. S. Venkateswaran

DR. S. VENKATESWARAN, deputy registrar of trade marks, India, has been appointed as registrar of trade marks in succession to K. S. Shavaksha, who has recently retired. Dr. Venkateswaran, who is a D.Sc. of the University of Madras and a law graduate of the University of Calcutta, was assistant chemist at

the Agricultural Research Institute, Pusa, and at the Government Test House, Alipore, during 1922–30, and has worked under Sir C. V. Raman, publishing several research papers on light scattering and Raman effect. He was elected a Fellow of the Indian Academy of Sciences in 1934. Dr. Venkateswaran joined the Indian Patent Office in 1930 as an examiner of patents and was successively special officer for trade marks (1940), assistant registrar (1940–44) and deputy registrar (1944 to date). He has been prominently associated with the enactment of the trade mark legislation in India, and his most important book, "The Law of Trade and Merchandise Marks" (1937), besides being a legal text-book, presents a complete case for trade mark legislation in India. The new Patents Bill is now before the Indian Parliament, and there is a proposal to combine the Patent Office and the Trade Marks Office again, as was the case before their separation in 1943 owing to certain administrative reasons. Although it is now more than fifteen years since trade mark legislation was enacted in India, India has not yet joined the International Convention for Industrial Property and there is no reciprocal arrangement for trade marks between India and other members of the British Commonwealth. It is understood that the Government of India is now actively considering the question of taking early steps to join the International Convention.

Charles P. Daly Medal of the American Geographical Society: Dr. J. K. Wright

Dr. John Kirtland Wright, geographer-historian, has been awarded the Charles P. Daly Medal of the American Geographical Society for his outstanding contributions to the field of geography through his administrative services, writing and research. Dr. Wright joined the staff of the American Geographical Society in 1920 as librarian, and served in that capacity until 1938, when he became director; in 1949 he resigned his post as director, and since then has devoted his time to research and writing. He was president of the Association of American Geographers in 1946, and during 1949–52 was chairman of the Commission (of the International Geographical Union) on the International Map of the World. The Daly Medal was established in 1902 in accordance with the will of Judge Charles P. Daly, eminent New York jurist and president of the American Geographical Society during 1864–99, and is awarded from time to time (thirty-seven times during the past fifty-one years) for "valuable or distinguished services or labors".

British Abstracts of Medical Sciences

As far back as 1915 the Physiological Society decided that an abstracting service for physiology was essential. It would be no over-statement to-day to say that such a service is absolutely vital for further progress. So voluminous has the literature become that no medical scientist can keep abreast of the publications in his field. With this in mind, a Committee representing the Anatomical, Biochemical, Endocrinological, Nutrition, Pharmacological and Physiological Societies decided that the cessation of *British Abstracts AIII* was unfortunate and that every effort should be made to continue this valuable abstracting service. As a token of goodwill and to ensure that a new journal would be launched, a sum of approximately £3,000 was subscribed by some of the above Societies. This enabled a start to be made, and the January 1954 issue of *British Abstracts of Medical Sciences* was published on January 20. Of the twelve monthly issues, seven have already appeared. The December issue will be an author and subject index, the work for which is already well in hand.

The *ad hoc* Committee of the above Societies decided that for success and security of the enterprise some form of legal entity was essential. This has been done, and the organization responsible for the continuance of *British Abstracts of Medical Sciences* is Biological and Medical Abstracts, Ltd., with registered offices at the Lister Institute. The Council of Management is made up of four representatives of the Physiological Society, two of the Biochemical Society and one each of the Anatomical, Endocrinological, Nutrition and Pharmacological Societies. The editorial office is also at the Lister Institute, where a full-time staff are engaged in the day-to-day running of the journal. In addition, there are twelve honorary specialist editors, chosen by the supporting societies, who supervise abstracting in their respective fields. Indicative abstracts of all significant papers in anatomy, biochemistry, endocrinology, experimental biology, experimental medicine, microbiology, odontology, pathology, pharmacology and physiology are prepared from more than six hundred journals published throughout the world by a large group of helpful abstractors. Every endeavour is made to publish these abstracts within six months of the appearance of the journal. Realizing that abstracts are of little value unless they (and the necessary indexes) are promptly produced, the Council hopes to reduce the time of publication still further. The composition and printing of abstracts is costly, so the price of £10 per annum, including postage, is made possible by the devoted labours of men whose aim is the advancement of their science.

Protection against Betatron and Synchrotron Radiations

The recommendations made by the National Committee on Radiation Protection, which are published in the United States as National Bureau of Standards Handbooks, serve as guides for protection against general hazards of radiation sources. The development in recent years of high-energy electron accelerators, some of which are now being built commercially, and their widespread use in hospitals and elsewhere make it necessary to provide the operators of these accelerators with a handbook warning them of the potential radiation hazards both to themselves, to patients in hospital and to the public, and of the appropriate precautions that should accordingly be taken. Handbook 55, "Protection against Betatron–Synchrotron Radiations up to 100 Million Electron Volts" (pp. 52. Washington, D.C.: Superintendent of Documents, 1954; 25 cents), prepared by Subcommittee 5 of the National Committee on Radiation Protection, deals with high-energy electron accelerators of the betatron and synchrotron types. The hazards resulting from the various radiations produced by the sources are considered, together with those due to certain associated effects, such as noise, electricity and ozone production. Since the experimental data relating to protection requirements for these sources are far from complete, and thus measurement techniques and systems of units are not well established, the handbook includes an initial section in which definitions of the various

technical terms used are clearly stated and listed, and nine appendixes in which detailed discussions are given of proposed units and measurement procedures. The following are dealt with in particular: the choice of the units for radiation intensity (watt/cm.^{2}) and for dose (erg/gm.), thus avoiding the use of the roentgen; the choice of a radiation-intensity secondary standard; a 5-cm. thick 'Lucite' cover for the sensitive element of a survey instrument; and the recommendation for high-energy installations of the standard personnel-monitoring procedures at present in use for radiations of less than 2 MeV.

United States Unclassified Material on Atomic Energy

THE United States Atomic Energy Commission has named the Stanford Research Institute, California, as one of three national industrial information depositories of unclassified information concerning developments in the field of atomic energy, the other two depositories being the Atomic Industrial Forum of New York and the John Crerar Library of Chicago. The Stanford Research Institute will serve particularly the western States and Hawaii and Alaska, by maintaining the collection and providing library, reference, photocopy and literature-search services to public interests. It has recently received an initial complement of materials consisting of seven hundred reports of industrial interest selected from 9,500 'basic science' reports filed with the Atomic Energy Commission, as well as a set of reproductions of drawings for a 'swimming pool' reactor, all the back issues of *Nuclear Science Abstracts* and sets of bibliographies of selected reports of value to industry. Mr. William A. Casler has been appointed to take charge of the depository. In December 1952 the Institute opened a Radiation Engineering Laboratory for industrial research with radioactive materials, the source of cobalt-60 provided to the Laboratory by the Atomic Energy Commission being the largest released for such use at the time. The previous year the Institute published results of a study sponsored by the Commission on "Industrial Uses of Radioactive Fission Products".

Financial Estimates for the Department of Scientific and Industrial Research

IN reply to further questions in the House of Commons on July 27, the Parliamentary Secretary to the Ministry of Works, Mr. J. R. Bevins, stated that the published estimate of £6·25 million for the Department of Scientific and Industrial Research for the present financial year represented an increase of £578,000 over last year (not £71,440 as stated in *Nature*, August 7, p. 251), of which £230,000 was part of the projected expansion by £900,000 over five years. The gross expenditure had increased from £5·8 million in 1952 to £7 million in the present year. The non-industrial staff, 3,108 on July 1, 1954, compared with 2,500 in 1949, would be increased to 3,900 in 1959, when the general level of activity would be 95 per cent of that projected in the expansion plans of 1947–48. At present the cost of the research on sulphate-reducing bacteria, on which twelve people were engaged at the Chemical Research Laboratory, was about £13,000 a year, and that of the work on corrosion of buried pipes, on which six people were engaged, about £6,000 a year. Studies of marine bacteriology, smoke curing, hygiene of fish handling and freezing at the Torry Research Station were at present held up on account of insufficient staff and inadequate buildings. On July 30 Mr. Bevins also stated that during the period April 1946–July 1954 the Department had made grants totalling £1,621,700 to the universities for the construction of high-energy particle-accelerating machines for nuclear physics research, and that grants of £747,200 had so far been made for running costs during the period August 1952–July 1957.

Survey of Scientific Journals in the United States

THE report of a survey of the operations and finances of scientific journals in the United States has been published in a recent issue of *Science* (**119**, 357; 1954). The survey, by R. Tumbleson and Helen L. Brownson, is based on the 110 replies received to 205 questionnaires distributed by the National Science Foundation to a selected list of periodicals, with circulations ranging from five hundred to sixty thousand or more, seeking information regarding circulation, volume of original research papers published, papers awaiting publication, sources of revenue and expense items. No data are included for periodicals of the American Medical Association or the American Chemical Society; but about 71 per cent of the replies related to the journals of scientific societies, and in this group 58 per cent of subscribers were members; for periodicals with a circulation of four thousand or less, this figure was 50 per cent; for more than four thousand, 68 per cent. This group of periodicals published on the average nine hundred pages of original research material, or about 70 per cent of all papers submitted; many of the others were rejected because they were submitted to the wrong periodical. Seventy of these periodicals had a delay for accepted articles of less than six months; twenty-five, a delay of six months to a year, and five of a year or more, the average being 5·3 months for those publishing five hundred pages or less a year and 1·9 months for those publishing more than two thousand pages; for periodicals publishing articles averaging four pages or less, the delay was 5·6 months compared with 2·1 months for those in which the average article was twenty pages or more. Subscriptions and society contribution in lieu of subscription represented 67·2 per cent of the income for periodicals with a circulation of less than a thousand, 69·8 per cent for those with a circulation of 1,000–7,999, and 45·2 per cent for those with more than 8,000; advertising revenue was 0·7 per cent, 14·2 per cent and 51·5 per cent, respectively. Most editors disliked the idea of a direct subsidy from any sources, including the Federal Government, and many believed that additional income should be obtained from society membership or advertising. Attention was directed to difficulties, expense and delay caused by bad writing and presentation.

Lancaster Royal Grammar School: *The New Biologian*

THE third issue of *The New Biologian*, the journal of the Natural History Society of Lancaster Royal Grammar School, has recently been published (June 1954). In the report of the Society's activities, by P. Brindley, it is recorded that a three-day exhibition was held in the biology laboratories, and several lectures given and films exhibited. P. F. Williams and P. E. Walker describe the bird-life of a hundred-acre field, where they concentrated mainly on the two heronries. G. J. Beckett gives an illustrated account of fern-collecting in northern England: it is unfortunate that in the caption of one illustration

the word 'spleenwort' is spelt in three different ways. It is a pity that in this article, and indeed in all the other articles, the generic and specific names are printed in the same Roman type as the rest of the text. Other articles recording some excellent field-work include hover-flies by R. Underwood, the birds of Arkholme by A. N. Gardner, the molluscs of Port Erin (I.O.M.) by P. Brindley, and British mountain scenery by F. D. Stell. Other articles include the meteorological summary for June 1953–May 1954 by J. I. Sharp, a description of making prints of leaves, etc., on photographic paper by A. M. Till, trout by G. Smith, collecting bees, wasps, etc., by T. H. Pennington, some observations of *Amoeba* by P. F. Williams, and a short description of giant tadpoles by G. H. Briggs.

Corrosion Technology

Starting in March this year, *Corrosion Technology* was published as a supplement to *Chemical and Process Engineering*, and from June it has appeared as a separate monthly journal, published by Leonard Hill, Ltd., of London (1, No. 4; June 1954. 40*s*. a year, or 100*s*. for 3 years). There are now, therefore, two monthly journals devoted to the subject of corrosion, the other being *Corrosion Prevention and Control* (see *Nature*, May 8, p. 853). *Corrosion Technology* carries three columns to a page, 12 in. by 9 in. The journal includes many useful items of news concerning developments in methods of preventing corrosion, in addition to the technical articles by various authorities. These include one on "Corrosion in relation to Welding", by Dr. U. R. Evans, of Cambridge; others deal with the corrosion resistance of welded stainless steel, paint versus corrosion, cathodic protection, corrosion research at the Chemical Research Laboratory, Teddington, rubber linings to protect plant in a new bromine factory, prevention of corrosion by water in oil refineries, non-metallic materials of construction for handling radioactive wastes, radioactive testing of rust preventives, corrosion of aluminium cable sheathing, cutting fluids and corrosion, and corrosion and tablet machinery. The variety of the topics reflects the wide range of the subject of corrosion. The journal is well produced, and it serves a useful purpose in providing corrosion workers, as well as engineers and others concerned with protection against corrosion, with up-to-date news and reviews of recent developments in the subject.

Periodicals in South Asia on the Physical and Biological Sciences

With the assistance of the United Nations Educational, Scientific and Cultural Organization, the Indian Library Association has now published Vol. 1, covering the physical and biological sciences, of a "Union Catalogue of Learned Periodical Publications in South Asia" (pp. 390. Delhi: Indian Library Association; London: George Blunt and Sons. Rs. 25, 9 dollars or 60*s*.; 1953). It is essentially the work of the Department of Library Science of the University of Delhi, and its publication represents the partial fulfilment of an aspiration of Dr. S. R. Ranganathan, the principal editor, twenty-five years ago; all the collaborators are past or present students of his. The Catalogue covers 175 libraries in India and 74 in Indonesia, Malaya, Burma and Ceylon. It consists of a Systematic Catalogue, arranged according to the Colon Classification, and indicating the status or subject of specialization of the library, as well as the holdings, and of an alphabetical index, in which title words of periodicals are given in heavy type. There is also a schedule of sub-classes of the Colon Classification covered and a key to library numbers. The Catalogue should prove of great assistance to research workers in South Asia.

Society for General Microbology

The Society for General Microbiology has recently undergone some reorganization and has established a central office at the Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1, to which inquiries regarding applications for membership and payment of subscriptions should in future be directed. Other matters should be communicated to the appropriate officer of the Society, and inquiries about the *Journal of General Microbiology* to the Cambridge University Press. At the last annual general meeting a new set of rules of the Society was passed, which now govern its activities. The nineteenth general meeting is to be held in the University of Reading during September 14–16 and is to include a discussion meeting on the "Principles of Microbial Classification". New officers of the Society are as follows: *General Secretary*, Prof. K. E. Cooper (Department of Preventive Medicine, University of Bristol); and *New Members of Committee*, Dr. B. W. Lacey, Miss June Lascelles and Dr. P. Tate. The remaining officers are: *President*, Mr. H. J. Bunker; *Treasurer*, Prof. R. Lovell; *Editors of the Journal*, Prof. B. C. J. G. Knight and Mr. A. F. B. Standfast; and *Meetings Secretary*, Dr. E. F. Gale (Department of Biochemistry, University of Cambridge).

Biology of the Trout

Regular observations have been made by the Scottish Home Office Brown Trout Research Laboratory, near Pitlochry in Perthshire, on freshwater biology in that area. Under the title of "Spawning Migration, Reproduction and Young Stages of Loch Trout (*Salmo trutta* L.)", Mr. T. A. Stuart has now recorded the results of research on the behaviour, reproduction and development of trout in their natural spawning grounds in three lochs, Lochan an Daim, Dunalastair Reservoir and Loch Moraig (Freshwater and Salmon Fisheries Research, No. 5. Pp. 40. Edinburgh: H.M.S.O., 1953; 7*s*. 6*d*. net). While the gonads appear to ripen at approximately the same time each year, the dates of spawning are influenced by the temperature. Prior to the spawning migration, a shoaling habit is formed and the trout congregate at the entrance to the streams chosen for spawning. Shoaling was only in evidence when the temperature of the loch water dropped to about 9° C. The main spawning run took place when the temperature of the streams dropped for the first time to 6–7° C. and was lower than that of the loch. In his observations on the trout's behaviour in forming the redd, Mr. Stuart has made the notable discovery that, apart from selection of gravel of suitable size, appreciation of the current conditions plays a most important part. He has shown that towards the tail-ends of pools, where the gravel slopes upwards, there is a point at which the current flows downwards through the gravel and keeps it free of silt. The trout are evidently aware of this and, after testing movements, come to rest there, probably aided by the slight suction from below. At such points the redds are made. Further interesting observations are recorded on the reactions of the alevins to light, the ventilation of redds by the

movement of their pectoral fins, and the re-entering of the gravel by the post-larvæ. This paper constitutes the most objective account of the early life of the trout yet available.

Nigerian Vegetation

In a short memoir, under the above title, R. W. J. Keay has presented an outline account of the main vegetational types of the very considerable and varied Nigerian territory. His aim is to interest and instruct agriculturists, foresters, naturalists, educationists and others in the botany and geography of Nigeria, no general account of the vegetation of this region having hitherto been available. In this extensive region the vegetation ranges from wet rain forest to very dry thorn savannah, few single African countries presenting such a range of vegetational types. The author rightly reminds his readers that only a relatively narrow coastal belt is covered with rich rain forest, the greater part of the hinterland consisting of savannah. The latter is clothed in tall grasses during the rainy season but becomes bare and open during the dry season when the grass is burnt. The thorn savannah occupies only a small area in the extreme north, with the Sahara desert over the frontier still farther to the north. The forest regions are described under the headings of mangrove forest and coastal vegetation, freshwater swamp communities, and the lowland rain forest zone; the savannah regions are discussed under four different zones; and an account is given of the montane vegetation with special reference to the very interesting floristic region of Cameroon Mountain (13,350 ft.). The results of various ecological studies have been worked into this, the second edition of this work. Some useful and interesting vegetation profile diagrams and a comprehensive, if as yet provisional, map of the principal vegetation zones are appended to the text. The memoir is published by the Government Printer, Lagos, Nigeria, and can also be obtained from the Crown Agents, 4 Millbank, London, S.W.1.

Pathogens of the Sugar Maple

A further paper in the extended series of studies in forest pathology in Canada is contributed by V. J. Nordin on the causes of decay in the sugar maple (*Acer saccharin*) in Ontario (*Canad. J. Bot.*, 32, 221; 1954). Decay results in appreciable losses in volume of sound wood. Seventy-four per cent of 606 sample trees had some measure of decay. Twenty-eight fungi were found to be associated with decay in living trees. The most important of these are *Armillaria mellea* (Vahl ex. Fr.) Quél., *Polyporus glomeratus* Peck, *Ustulina vulgaris* Tul., *Fomes connatus* (Weinm.) Gill., *Hydnum septentrionale* Fr., *Corticium vellereum* Ell. and Crag., *Pholiota spectabilis* Fr., and *Fomes igniarius* (L. ex. Fr.) Gill. Several species previously unreported in the literature were found to be associated with decay in sugar maple in Ontario. *Armillaria mellea* is the most serious butt-decay fungus and *P. glomeratus* is the most important trunk-rotting species. Frost cracks are the most important site of entry for fungi. Various discolorations occur in sugar maple. The average extent of decay in living trees is estimated according to the occurrence of sporophores of *F. connatus*, *F. igniarius*, *H. septentrionale* and *U. vulgaris*. The incidence and volume of decay increased progressively with age and diameter. One hundred and nine species of Basidiomycetes are tabulated as occurring on living and dead sugar maple in Ontario. This paper is illustrated by a large number of plates.

Aboriginal Rock-paintings in Australia

Until quite recently there had been little evidence of aboriginal occupation in New South Wales. Investigations by W. H. Kinsela in the area immediately south of Sydney and extending throughout the Illawarra coast and tablelands have shown that, besides the well-known kitchen-middens, there are several groups of rock-paintings (*Aust. Mus. Mag.*, 11, No. 4). In the Avon River valley, for example, one group of paintings contained many figures drawn in black, the dominant one being a woman with exaggerated breasts. Some others, including a wombat, were in red. Among the charcoal pictures is the realistic side-view of a human, in silhouette, with a genuine attempt to put natural shape into body and limbs. The paintings throughout the whole of this 'new' area of the South Coast tablelands are typical of the species, style and technique seen elsewhere in eastern New South Wales. There is, however, a marked absence of the mass-patterns of stencilled-hand paintings which are seen so frequently in Hawkesbury Sandstone areas north from the South Coast. The majority of the paintings visited are fairly faint, and difficult to reproduce by photography.

Colonial Development Corporation: Report for 1953

The annual report and accounts of the Colonial Development Corporation for the year ended December 31, 1953 (pp. 50. London: H.M.S.O., 1954; 2*s*. net), records the initiation of five new projects, the abandonment of seven projects and the termination of the East African ramie investigation, the Kenya fish farms and the Vitingini lead investigation, leaving fifty continuing projects and investigations. Capital sanctioned increased from £39,400,000 in 1952 to £43,512,000 in 1953, mainly for productive projects, of which agriculture, animal products, forestry and minerals now account for 54 per cent, or 56 per cent of the £25,349,000 employed, and several agricultural/forestry projects now in early phases of development will eventually need large expenditures to bring them to completion. A further substantial reduction in head-office administration costs was effected during the year, the United Kingdom staff being reduced from 248 to 183 and regional offices staff from 114 to 106, but further reduction is unlikely at the present scale of operations. For most projects the local labour is fairly efficient, though in some areas it is low, due mainly to poor physique, malnutrition, debilitating diseases and lack of education. In agricultural research a panel of agricultural scientists established in London in March 1953, with Sir Charles Darwin as chairman, has been of great help, and the Corporation's experiences and problems are made known to those who allocate Colonial Development and Welfare funds for agricultural research, affording an indication of priorities in this field.

National Museum of Wales: Report for 1952–53

The forty-sixth annual report of the National Museum of Wales, Cardiff, covering the year 1952–53 (pp. 63; from the Museum, Cardiff; 1953), is the first to appear in the new format. The smaller size is more interesting and handier and is to be commended as a type of production to be copied. It is

stated that unfortunately there is no possibility of a licence being obtained for the extension to the west wing of the Museum, though, on the other hand, it is possible that one may be issued for a smaller building to serve as a beginning of a museum block at the Welsh Folk Museum, St. Fagans. This would permit the removal to St. Fagans of folk-life material and lead to a reorganization of the first-floor galleries at Cardiff. The freeing of the circular gallery for temporary exhibitions would be a welcome action. Work in the geological gallery has been devoted towards improving the appearance but not the essential range and purpose of the exhibits. At the Welsh Folk Museum the chief activity has been again the re-erection of buildings. The Montgomeryshire house is now thatched and wattled, and the stone house from Gower is nearing completion. An upland farmhouse from Dyffryn Claerwen, Radnorshire, has been accepted and will provide the Museum with its first complete unit of stable, cowhouse and dwelling.

National Research Council of Canada: Awards for 1954–55

The National Research Council of Canada has granted 236 scholarships for 1954–55, totalling in value 283,200 dollars. These scholarships include 75 bursaries worth 800 dollars each, 103 studentships worth 1,100 dollars each and 21 fellowships worth 1,400 dollars each, all of which are to be held in Canada. Special scholarships awarded for study abroad include twenty awards worth 1,900 dollars each, which will be held in the following countries: ten in the United States, eight in the United Kingdom, one in France and one in Sweden. Seventeen overseas postdoctorate fellowships worth 2,500 dollars each have been granted for work in the following countries: twelve in the United Kingdom, two in Sweden, one in Denmark, one in France and one in the Netherlands.

Colonial Service: Recent Appointments

The following appointments have been made in the Colonial Service: D. W. Malcolm (principal assistant secretary, Tanganyika), secretary for agriculture and natural resources, Tanganyika; A. F. Mackenzie (deputy director of agriculture, Sierra Leone), director of agriculture, British Guiana; F. E. Hughes (deputy chief conservator of forests, Gold Coast), chief conservator of forests, Gold Coast; I. G. John (assistant director, Malayan Meteorological Service), director Malayan Meteorological Service; N. S. Sandeman (assistant game warden, Uganda), game ranger, Kenya; A. J. Vincent, assistant conservator of forests, Federation of Malaya; A. Crosbie, veterinary officer, Northern Rhodesia; Miss E. R. Blydenstein, meteorologist, East Africa High Commission; J. O. Goss, agricultural officer, Nigeria; B. G. Hoare, agricultural officer, Gold Coast; A. R. Longhurst, scientific officer, West African Fisheries Research Institute, Sierra Leone; W. G. Owen, geographer, Hydrological Survey Department, Uganda; J. F. Truswell, geologist, Nigeria.

Announcements

The Atomic Energy Authority announces that Mr. W. R. J. Cook, chief of the Royal Naval Scientific Service since 1950 (see *Nature*, 166, 135; 1950), has been released from his present post to take up that of deputy director of the Atomic Weapons Research Establishment, Aldermaston, the director of which is Sir William Penney.

The Lister Medal for 1954, which is given in recognition of distinguished contributions to surgical science, has been awarded to Mr. Victor Ewings Negus, consulting surgeon to the Ear, Nose and Throat Department of King's College Hospital, London, in recognition of his services to the advancement of knowledge in the surgery of the nose and throat by means of his researches into the comparative anatomy and physiology of the larynx and para-nasal sinuses. This is the eleventh occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.

The College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1954 to Dr. DeWitt Stetten, jun., associate director in charge of research, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland, for his outstanding contributions to knowledge of metabolic diseases. The Alvarenga Prize was established by the will of Pedro Francisco DaCosta Alvarenga, of Lisbon, an associate fellow of the College, to be awarded annually on the anniversary of his death on July 14, 1883.

The Faraday Society will be holding a general discussion on "Coagulation and Flocculation" in the Department of Chemistry, University of Sheffield, during September 15–17, under the chairmanship of Prof. R. G. W. Norrish, president of the Society. The twenty-nine papers to be presented will be divided into three groups, with introductory addresses for each group by the following: classical coagulation, Prof. J. T. G. Overbeek (Utrecht); coacervation, Dr. A. S. C. Lawrence (Sheffield); and biological systems, Dr. J. R. Marrack (Cambridge). Advance proofs of all the papers will be available about the end of this month. Applications for accommodation (to be made not later than September 6) and all other inquiries should be sent to the Secretary of the Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

The Oil and Colour Chemists' Association will be holding a symposium on "Rheology and Settlement of Pigmented Systems" on September 23 in the Chemistry Theatre of University College, Gower Street, London, W.C.1. In the morning Prof. Stacey G. Ward will give a lecture on properties of well-defined suspensions of solids in liquids, and Mr. J. Pryce-Jones on the rheological state of a suspension as a criterion for the study of the flow and settlement of paints. The afternoon session will be devoted to a discussion on these two papers. The symposium will be open to non-members on application to the general secretary of the Association, R. H. Hamblin, Memorial Hall, Farringdon Street, London, E.C.4, from whom further information can be obtained.

The ninth Annual Calorimetry Conference in the United States will be held in the General Electric Research Laboratory, The Knolls, Schenectady, New York, during September 17–18, under the chairmanship of Dr. E. J. Prosen (National Bureau of Standards, Washington, D.C.). The conference is open to all, without registration fees. Further information can be obtained from Dr. Warren DeSorbo, General Electric Company, Metallurgy Research Department, Research Laboratory, P.O. Box 1088, Schenectady, New York.

INSTITUTION OF ELECTRONICS EXHIBITION IN MANCHESTER

THE ninth Annual Exhibition of Electronic Devices, organized by the North-West Branch of the Institution of Electronics, was held in the Manchester College of Technology during July 14–20. The Exhibition was as large and efficiently organized as any of its predecessors, and was as deservedly popular. It included, in addition to exhibits in the commercial and research sections, a programme of general and specialized lectures, and a number of illustrative film shows. For an affair of this size—some forty exhibitors were represented—a detailed review cannot be given; the writer must restrict his attention to a few of the features which he found most interesting.

The commercial section was impressive chiefly for its evidence of steady progress in the development of known techniques. Applications of television were prominent, and there were on view no fewer than three industrial closed-circuit television channels (by Pye, Philips Electrical, and J. Langham Thompson). Low-inertia integrating motors were shown by Electro Methods, Ltd.; these motors have practically straight voltage-speed characteristics, and are used for time integration of minute voltages. The Saunders–Roe exhibit included some interesting and, incidentally, very handsome strain gauges. These are made of metal foil etched into suitable strain-sensitive patterns, and mounted on an epoxy resin lacquer backing. They are more robust than conventional wire gauges, and permit a higher input current without compromising stability. Part of the large Mullard exhibit consisted of a formidable array of ultrasonic devices. Among them was an ultrasonic drill press, designed for the drilling or machining, by the action of an abrasive slurry between the vibrating tool and the work, of such intractable materials as glass. Equipment for the ultrasonic cleaning of fragile or inaccessible objects, and an ultrasonic soldering-iron capable of dealing with aluminium, were also demonstrated.

Prominent in the research section were the stands of the British Rayon Research Association. Among the recently developed instruments on display was an ingeniously simple autocorrelogram computer, used for the separation of periodic from random irregularities in yarns. The same exhibit included a demonstration of equipment used in flash photolysis. In this technique an intensely bright flash of short duration is used for irradiating a specimen, and after a selected interval of 20 μsec. or more, a second, less bright, but shorter, flash is used to record the absorption spectrum of the specimen. In this way the presence and decay of short-lived products of irradiation can be studied.

The Institute of Cancer Research exhibited ultrasonic echo-locating equipment, used for the examination of brain structure. When the equipment is in use, a quartz transducer in acoustic contact with the head emits a narrow, pulsed beam of ultrasound. Any echoes incident on the transducer are transmitted as pulses through amplifier and display circuits, and appear on an oscillograph screen. The position of the pulse on the screen gives a measure of the distance of the source of the echo from the transducer. At present, observations are being compared with what is known of the 'normal' brain, with the view of the possible identification of abnormal structures. In view of the drastic effects of ultrasonic vibrations, as demonstrated in the Mullard exhibit, it should be mentioned that the power output of the transducer is only 30 μW. Since the vibrations suffer considerable attenuation on entering and leaving the skull, it is clear that high sensitivity is required of the amplifiers.

A portable twelve-channel toposcope, designed as an aid to the increasingly important subject of electroencephalography, was exhibited by the Burden Neurological Institute. The complete study of the simultaneous electrical activity associated with a number of points on the head, for a significant period, is bound to be almost prohibitively time-consuming. The purpose of the toposcope is to restrict severely the type of information to be studied, and to present it in a rational manner. The equipment can be set for a desired frequency, or alternatively it can be made to set itself servo-mechanically for the predominant signal frequency of any selected channel, and in this condition it is sensitive only to that frequency or its harmonics. The display panel consists of a number of cathode-ray tubes, and each of these indicates for one of the channels (that is, for one of the selected points on the head) which, if any, of the harmonics of the driving signal is present, and what its relative phase is. A larger version of the equipment has been in use at the Burden Institute for the past two years, and has proved to be of particular value in research on the functional anatomy of the brain.

The Exhibition as a whole has proved to be of the highest interest to very many visitors, and due credit must be paid to the exhibitors and organizers alike.

A. W. HANSON

BRITISH CAST IRON RESEARCH ASSOCIATION

OPEN DAY

THE British Cast Iron Research Association, Birmingham, held an open day on July 7 for representatives of member-firms, some three hundred of whom attended, being welcomed by the president, Sir Frederick Scopes. The next day some hundred and fifty attended from other research associations, government laboratories, trade associations, technical institutions, universities, technical colleges and schools.

The extensions last reported (*Nature*, **170**, 153; 1952) have been fully brought into use, except for the new melting shop, which has yet to be equipped, but which in the meantime is being used for work on foundry atmospheres. The Association has been negotiating with the Department of Scientific and Industrial Research with respect to arrangements for its new grant period, during which it is hoped a further stage of expansion will be reached.

A feature which attracted considerable interest was a display of art castings in moulded iron, in-

volving very advanced skills in pattern-making and moulding. The importance of maintaining these skills is indicated by the adoption in recent years of such medieval methods as the lost wax process for producing jet engine parts which have to be cast to very accurate tolerances, and to their final dimensions, since they are frequently too hard to machine.

The experimental work on view included the study of the mechanism of blister formation on porcelain-enamelled cast iron, the gas originating the blister defect being removed during heating in a stream of argon and measured by an infra-red gas analyser. The application of strain gauge techniques to measure stresses set up in actual castings in service was illustrated. An important section related to work on white and chilled cast irons as used in the roll-making industry and referred to the effect of various conditions, composition and temperature, affecting the depth of chill.

Considerable advance was shown in the section on moulding and core sands tested at the elevated temperatures to which they are subjected in practice by induction heating, and the mechanism of the formation of defects due to sand failure was shown by a working model. A train for the production and casting of shell moulds of resin-bonded silica sand, about 5 mm. thick, was demonstrated, together with a newly devised arrangement for testing the material itself. Other work on moulding sands related to their effect on the shrinkage characteristics of the cast metal and on surface finish. The pore size of sand aggregates has been shown to affect heat transfer, mould permeability, gas flow during pouring and metal penetration.

The vacuum fusion method has been developed to yield quantitative information on the gases present in cast iron, especially oxygen and nitrogen, and the vacuum heating principle is used for the determination of hydrogen. Gamma-radiography was demonstrated for determining unsoundness in castings. The use of cathodic protection for cast iron pipe lines in aggressive soils and for propellers in sea-water was shown. In the analytical block a variety of demonstrations was in progress on chemical methods of examination and on spectrographic analysis, the latter including foundry slags.

Although no formal programme on the problem of brittle fracture has existed, since this problem mainly concerns the steels, a useful result has emerged from parallel studies of two aspects of the properties of ferritic nodular iron castings—properties at low temperatures and properties under impact. It appears that the ferritic nodular irons are better suited to resist the phenomenon of brittle fracture than many steels. Transition temperatures for ordinary ferritic nodular iron may be as low as −50° C., and with specially chosen raw materials this could be reduced to −100° C.

The work of the Foundry Atmospheres Team has made considerable progress. The control of dust on practically every type of rotating wheel used for cleaning and grinding castings, many of which are common to a wide range of other industries, has been established, and some devices are in commercial production. A systematic study of the behaviour of dust-laden air streams at the knock-out, where castings are normally separated from their sand envelopes, has been begun. A satisfactory design of wet spark arrester for cupola furnaces has been evolved and will assist in dealing with external atmospheric pollution.

J. G. Pearce

BRITISH COLONIAL TERRITORIES

REPORT FOR 1953–54

IF the proposals of the White Paper entitled "Reorganization of the Colonial Service" (Colonial No. 306. London: H.M.S.O., 1954; 4*d*. net) are implemented, the recently published report on "The Colonial Territories 1953–54"* may be the last survey to appear under that title. It is proposed to constitute from October 1, 1954, an Oversea Civil Service which will include all those officers now in the Colonial Service who have been selected for their present posts by the Secretary of State for the Colonies whether or not the territory in which they are serving attains self-government. Should the territory attain self-government, their conditions of service and pension rights will be safeguarded by formal agreement between the Government in the United Kingdom and the Government of the territory. When the new Service is in being, any offer of appointment will include a clear statement whether it carries membership of the Oversea Civil Service or whether the officer's contractual relationship will be solely with the territorial Government. Officers in either category will be expected to regard themselves as being in all respects responsible to the territorial governments under which they are serving.

The new form of Service is intended to safeguard the interests of existing officers as well as to overcome political difficulties or prejudices which are more fully indicated in the review of constitutional and administrative developments in "The Colonial Territories 1953–54" report than in introductory paragraphs of the White Paper. It is also intended to encourage qualified men and women to continue to come forward in a spirit of confidence, enthusiasm and partnership and to assist the social, economic and political progress of the overseas governments and peoples. The present decisions are not intended to exclude the constitution of a Commonwealth service or an overseas service directly employed by the British Government, but the Government has not yet reached any conclusions on the complicated administrative and constitutional, as well as financial, problems involved in such proposals.

Apart from providing a very convenient conspectus of the political, economic and financial, and social developments in the Colonial territories for prospective candidates for appointments in the Colonial Service, whether scientific or not, "The Colonial Territories 1953–54" is also of interest to the man of science as providing the background against which progress in Colonial research, for developments in education, in health and welfare, and in communications and industry in these territories are appropriately considered. In particular, the surveys of constitutional and of economic and financial developments should facilitate both responsible criticism of particular developments and a general understanding of the extent to which economic and social developments, as well as the application of the results of the research at present in progress, depend on education.

In all branches of education the expansion of facilities continued during 1953–54, and special stress is laid on the increased provision for training teachers, alike in Malaya, Singapore, and Hong Kong, in the larger West African territories (where in view of

* Colonial Office. The Colonial Territories 1953–54. (Cmd. 9169.) Pp. xii+196. (London: H.M. Stationery Office, 1954.) 6s. net.

the rapid expansion in primary education determined efforts are being made to maintain standards of efficiency), in Kenya and in Tanganyika. In Uganda, where the output of trained teachers is to be increased to about 1,150 by 1956, the British Government has allocated £8 million from the African Development Fund over the period 1953–60 to implement the recommendations of the de Bunsen Committee as well as £2 million for the development of technical education. In Northern Rhodesia, the establishment of a unified African teaching service was finally approved, and £1,250,000 was allocated from Colonial Development and Welfare Funds for the establishment of Rhodesia University College, the foundation stone of which was laid at Salisbury by the Queen Mother on July 13, 1953. During the academic year 1953–54 there were 3,639 full-time students at the three universities and four university colleges, and steps were taken during the year to strengthen the intimate relations between the Colonial institutions and other universities, particularly through a Colonial Development and Welfare grant to facilitate secondment of staff to the Colonial universities and colleges, and the extension of the Commonwealth Interchange Scheme to cover visits to and from Colonial institutions. Educational exchange was also assisted under the Fulbright Agreement, nineteen men and women from the Colonial territories receiving travel grants under this scheme for study or research in the United States, and thirteen American lecturers, research scholars or students being selected for attachment to Colonial universities. Of nearly eight thousand Colonial students in the United Kingdom and the Irish Republic at the end of 1953, 1,965 were scholarship holders, and the report again pays tribute to the work of the British Council in finding accommodation for these students. In higher technical education, the Nigerian College of Arts, Science and Technology had its first major entry of students. A Commission was appointed to make recommendations for the development of Fourah Bay College in relation to the educational requirements of Sierra Leone at all levels, and Major-General C. Bullard took up his post as first principal of the Royal Technical College of East Africa, Nairobi.

No widespread epidemic occurred during 1953, and available figures point to an almost universal fall in mortality-rates and a general rise in the expectation of life. Human trypanosomiasis is now fairly well under control in Africa but only as a result of constant vigilance and the maintenance of active control measures. In Fiji, where filariasis is very prevalent, an attempt was made at control by mass administration of 'Hetrazan' in conjunction with a campaign against the mosquito vector. Yaws is fast disappearing from closely settled areas, and the scientific application of insecticides eliminated relapsing fever from the Somaliland Protectorate. Tuberculosis, however, remains a grave problem, and while treatment with modern drugs and antibiotics has proved very effective, present facilities for diagnosis, treatment and control are inadequate. Spectacular progress has been made in the control of malaria and leprosy; but much research is still needed to elucidate the provocative factors in the epidemiology of kala azar, of which three thousand cases were reported in Kenya up to the end of 1953.

The review states that the flow of recruits to the Colonial Medical Departments is insufficient, and although an increasing number of doctors of local origin are becoming available for service in their own territories, recruits from the United Kingdom are urgently needed, particularly for Nigeria and the Pacific. On December 31, there were 230 scholarship holders and 595 other students from Colonial territories in the medical schools of the United Kingdom and the Irish Republic as well as 97 students of dentistry, most of whom were expected to return to work in their own countries, while considerable numbers of doctors are also being trained in the Universities of Malaya and Hong Kong and the University Colleges of the West Indies and Ibadan. Training schemes for medical auxiliaries remain an urgent priority, and although the number of Colonial student nurses in training in the United Kingdom continues to increase rapidly, recruitment of nursing sisters from the United Kingdom and Commonwealth countries was difficult and new appointments did not keep pace with resignations. The scheme for the provision of a panel of medical visitors to the African territories has proved a success, and it is hoped that the scheme will be continued and a similar scheme introduced in other areas.

Expenditure on development and welfare schemes and on research was again approximately £14 million. In addition, a loan of £2,390,000 for the development of the East African parts of Mombasa and Tanga was made from sterling Counterpart funds by the United States Government. Fifty-nine research schemes, estimated to cost £741,000, were approved during the year, thirty-one new appointments were made on Colonial Research Service terms and seven research studentships were awarded. The progress in research, which is summarized in the chapter on "Research and Surveys", is to be covered more fully in the subsequent report "Colonial Research 1953–54", and it will suffice here to note that the West African Government has agreed to set up a Permanent Standing Advisory Committee for Agricultural Research, and that the establishment of a Regional Research Centre in the West Indies is receiving attention. Most of the Colonial governments have now agreed to the establishment of a Colonial Road Research Station, though only a few to the establishment of research funds in the Colonial territories. Arrangements are now being made to establish a Colonial Road Research Section at the Road Research Laboratory, Harmondsworth, and also the proposed Advisory Committee. The West African Regional Standing Advisory Committee for Medical Research has been converted into a Council for Medical Research, and administrative measures are in hand for a similar organization in East Africa. The establishment of a new entomological research station in Benin Province of Nigeria will permit an intensive study for the first time of those species of tsetse which occur in the high forest belt. At the West Africa Rice Research Station in Sierra Leone good progress was made with investigations on the development of mangrove swamps for rice-growing. In Nigeria the sealing-off policy in combating swollen-shoot disease of cacao did not prove completely effective, and further research on the behaviour of the virus is being carried out at a sub-station of the West African Cacao Research Institute opened at Ibadan. Successful research on the use of copper sprays has led to a large-scale campaign in Nigeria for the control of black-pod disease of cacao. Arrangements are being made to open a sub-station of the West African Institute for Oil Palm Research in Sierra Leone; but although the Institute continued its work on the establishment, nutrition, breeding and

diseases of oil palms, lack of staff made its Plant Physiology Division inactive. Thirty-one new appointments were made to the Colonial Research Service and seven research studentships were awarded to train candidates for research appointments.

Recruitment of field staff for geodetic and topographic surveys kept just ahead of transfers and resignations; but thirty-two new appointments to the cartographic staff were offset by thirty-seven resignations dismissals or call-up to national service. Nevertheless, very satisfactory progress was made with geodetic surveys. The overseas scientific staff of the Colonial Geological Surveys increased from 190 to 197 during 1953, and although there were still some twenty vacant posts, satisfactory progress continued in all branches, including geological mapping, the investigation of mineral resources, and in the geological aspects of engineering and water-supply projects.

Besides the expenditure from Colonial Development and Welfare Funds, the United Kingdom contributed approximately £20,200,000 from the Vote for Colonial Services during 1953–54, and the present report sounds a warning note in respect of finance. While public expenditure has continued to rise, as well as the total of Colonial government general and development reserves in London, financial prospects in many territories are not encouraging. Revenues in Nigeria and the Gold Coast continued to rise sharply as a result of the steady increase in cocoa prices, but in Malaya revenue was 20 per cent lower than in 1952. Tanganyika's revenue fell by more than 10 per cent, mainly as a result of the fall in sisal prices, while those of North Borneo and Sarawak also fell. Generally, the picture has been one of a flattening-out of the curve of revenue increases.

While capital goods have been easier to obtain, though not cheaper, and capital expenditure and development are at present limited rather by shortages of administrative and technical staff, it is clear from this report that developments in future may no longer be able to count on an almost automatic increase in revenue. More governments are likely to be faced with deficiencies in the near future if the present trends of revenue and expenditure continue, and the report emphasizes that the increase in government commitments and costs since 1939, particularly in the maintenance of the expanded social services, makes any decline in revenue a cause of alarm.

HYDRAULICS RESEARCH STATION

REPORT FOR 1953

THE report for 1953 of the Hydraulics Research Board* describes work done during the year at the Hydraulics Research Station, Wallingford, and also in the field. It covers a range of activities, including investigations, mainly by models, into the design of harbours, jetties and other coastal works, beach surveys, special investigations arising from the east coast floods of January 31–February 1, 1953, and a preliminary study, based on charts and maps, of drainage and reclamation works in the Wash.

Two parties from the Research Station visited a number of places on the east coast of England from Margate to Scarborough during the four days February 3–6, their main objects being to examine the damage to sea defences and beaches and to take photographs, before repair works were started or the return to normal conditions had obliterated the effects of the storm on the beaches. Experiments carried out on a pilot model of the Thames Estuary, at the request of the Waverley Committee, showed that if the freshwater flow had been at its maximum value of 20,000 cusec. at Teddington Weir, instead of the low value of 2,600 cusec. actually existing at the time, the high-water level in London would have been increased by 9 in., a result in good agreement with previous estimates.

An example of work carried out for other countries of the British Commonwealth is that done on two models of Lyttleton Harbour, New Zealand. The object of the investigation is to assess the merits of various proposed designs of harbour extensions from the point of view of protection from waves, susceptibility to ranging and the amount of dredging required. The tests carried out so far have been designed to reproduce the existing conditions. On the larger model, that of the inner harbour, the distribution of wave heights throughout the harbour has been plotted for several wave periods, and the response at a given point as the period of the waves is varied has also been examined experimentally. Another overseas project was the design of a weir block to prevent waves passing up the discharge channel for cooling water at the thermal power station recently constructed at Dekhelia in Cyprus.

The facilities for research on models will be increased when the first stage of the main hall of the Station, which will have a floor area of 300 ft. by 200 ft., has been completed; work on this was proceeding during 1953, and it is hoped that it will be ready for use early in 1955. One of the models to be housed in it will be a large model of the Severn Estuary, on which the effects of the proposed Severn Barrage can be examined. In the meantime, preliminary experiments are being made on a pilot model, which is largely a replica of that built by Prof. A. H. Gibson.

An investigation of a somewhat different kind has been started on land reclamation and drainage in the Wash, at the request of the Ministry of Agriculture and Fisheries. While training works, constructed at various times during the past hundred and fifty years to improve the outfalls of the four principal rivers, have had the desired subsidiary effect of increasing the area available for reclamation, they have been less successful in achieving their primary object, because of deterioration of the estuaries to seaward of them. By treating the Wash as a whole, it is hoped to be able to design extensions to the training works which will improve the outfalls and also result in an additional fifty thousand acres of saltings becoming available for reclamation.

While most of the work described was undertaken in connexion with specific engineering projects, an item of more fundamental research was that carried out in the wave tank on the effect of a vertical wall on a beach in front of it. After the beach had become stable under the action of waves and tides, the wall was inserted in a position between the high-water mark and the highest point reached by the swash.

* Department of Scientific and Industrial Research. Report of the Hydraulics Research Board with the Report of the Director of Hydraulics Research for the Year 1953. Pp. vi+58+8 plates+4 maps. (London: H.M.S.O., 1954.) 7s. 6d. net.

When the wave and tidal action was continued, the level of the sand against the wall fell until, after thirty-three tides, it was approximately at low-water level.

During coastal surveys in the Southwold and Christchurch areas, observations were made with drift indicators which showed that swell, accompanied by gentle or offshore winds, set up a drift which was shoreward near the bed and seaward at the surface. With steep waves accompanied by onshore winds, however, it appears that these directions are reversed. Among the new instruments developed is a miniature current meter for measuring the flow in models at velocities down to 0·25 in./sec.; this consists of a small plastic propeller the revolutions of which are timed electronically, making use of the change in conductance produced by the passage of each blade of the propeller between two electrodes.

K. F. BOWDEN

DRYING OF BIOLOGICAL CULTURES

JUDGED by replies to a questionnaire sent out in 1948, only twenty-five of ninety-five laboratories in the United Kingdom then used some form of drying technique for the maintenance of their stock cultures. Since that time the method has been applied much more extensively, and last September the British Commonwealth Collections of Micro-organisms arranged a discussion of the principles and methods of applying freeze-drying to culture maintenance to which home and visiting scientists were asked to contribute. The proceedings of the meeting have now been published*. In the event the discussion centred more on methods than on principles, about which we seem to be woefully ignorant.

Many methods are available for drying cultures on a small scale; but the only one readily applicable to the production of a large number of ampoules are those developed by R. I. N. Greaves from his experience of drying blood products. The designer's view is that the biologist is unnecessarily exacting, and to meet his requirements apparatus has become unduly expensive. Plant has to be designed to satisfy the biologist on three major points: the temperature of drying, the speed of drying and the rate of freezing; each of these is profoundly affected by small changes in technique, such as by increasing slightly the volume of material in each ampoule. The biologists are not prepared to accept the engineer's view that further developments lie with the bacteriologist; the best possible machine for the job has not yet been produced.

Of biological factors affecting survival of micro-organisms after drying, P. J. Fisher's work shows that the culture age is important, old cultures surviving better than young: it was suggested that autolytic breakdown products, such as deoxyribonucleoprotein, might have a protective action. The suspending fluid affects survival in at least two ways: during freezing, crystallization of salts may be injurious; but the main killing effect of the freeze-drying process takes place when the water is first taken off under vacuum. The ultimate survival-rate is improved by the addition of 7·5 per cent glucose to the suspending fluid, and, as survival also seems to depend on the residual moisture content of the dried product, it has been argued that glucose automatically controls the residual moisture. Unfortunately, moisture determination is technically difficult, but apparatus recently developed may so simplify the procedure that it will become part of the drying routine. With apparatus of this type it has been shown that, when solutions containing glucose are dried, moisture removal continues for three months. After sealing, there is an increase in vapour pressure in the ampoule which can be shown by a high-frequency discharge tester producing a glow inside the ampoule and not in the glass wall, and it is possible that there is a redistribution of moisture from the slow-releasing glucose to the protein which had been rapidly desiccated. In vessels closed with rubber stoppers there may be a re-hydration from diffusion of moisture through the rubber.

Freeze-drying may have some effect on the metabolism of surviving cells, and strains used for the production of antibiotics have been found to lose the ability to produce the dehydrogenase enzyme notatin. However, the experience of most of those taking part in the discussion was that, for bacteria and fungi, freeze-drying is the best method of keeping in stable form the metabolic activities which determine the biochemical reactions, antigenic patterns and the virulence of pathogens.

* British Commonwealth of Nations Scientific Liaison Offices, B.C.S.O. (London). A Discussion on the Maintenance of Cultures by Freeze-drying. Pp. ii+48+1 plate. (London: H.M. Stationery Office, 1954.) 5s. net.

THE FUTURE FOR TECHNOLOGICAL STUDIES

IN his Messel Memorial Lecture to the Society of Chemical Industry at Liverpool on July 14 (*Chem. and Indust.*, 940; July 31, 1954), Lord Cherwell suggested that recognition by the large chemical firms in Great Britain of the fact that fundamental research is essential to progress is the main reason why the British chemical industry has been able to develop so rapidly and to overcome its handicaps. No other industry in the country has shown so much foresight and understanding of the vital importance of fundamental investigation which at first sight might seem to have no relation with practical applications. First among the industry's handicaps is the lack of facilities in Britain for higher technological education. In spite of their efficiency and merit, the existing university departments of chemical engineering cannot meet all our requirements. In industrial atomic power the efficiency of the chemical recovery determines whether or not the plant is an economic proposition, and many more like Sir Christopher Hinton and his team are needed to tackle such novel and difficult problems. It is not possible in Britain, said Lord Cherwell, for a young man to study at university institutions the first principles of technology and the disciplines on which it is based before deciding which particular technology to follow, and it is wrong to confine teaching of the highest branches of technology to ordinary universities. Lord Cherwell argued again for a technological university—with some three thousand students and fifty or more professors—such as no existing university could accommodate without distorting its balance of studies.

The main obstacle to such a proposal, he urged, is intellectual snobbery regarding technology which

still pervades Britain, although it takes just as much brains to become a first-class technologist as to become a first-class lawyer, and probably more. Since this battle which he has fought for the past twenty years has been unsuccessful, Lord Cherwell found the reason for his being awarded the Messel Memorial Medal in his early work on physical chemistry, dating from that with Prof. W. Nernst in Berlin more than forty years ago. Nernst was then mainly concerned with the heat theorem known as the third law of thermodynamics, and Lord Cherwell showed briefly how a suggestion by Einstein regarding the derivation of Planck's formula led to the discovery that action could only be transferred in units of a minute but finite size. The processes for synthesizing ammonia or petroleum depend, in fact, on the reinstatement in a space–time description of the conjugated dynamical co-ordinate.

The world is now entering an epoch of nuclear chemistry, continued Lord Cherwell, about which our knowledge is as rudimentary as that of chemistry itself a hundred and fifty years ago. No one can say whether the building up or the breaking down of nuclei will play the predominant part in generations to come. Even in classical chemistry there are problems of which we have only scratched the surface, such as the extraction of the uranium and the plutonium after irradiation from the rods full of lethal fission products and the disposal of these intensely active products. Whether we can utilize the energy potentially available has yet to be seen, and meanwhile man for the first time has it in his power to destroy all life on this planet. The question is whether he will be able to avoid some such form of universal suicide, and it is a sad reflexion on our political achievements and mental processes that, despite the universal wish for peace, man has not been able so to arrange his affairs as to avoid war and the continuing threat of war.

STANDARDS AND LEVELS OF LIVING

A COMMITTEE of United Nations experts has concluded that most of the short-cut methods for comparing levels of living in different countries are unsuitable and sometimes misleading. For example, both national income *per capita* and real wages have serious defects as indexes of levels of living*.

To present useful comparison the committee recommends a pluralistic approach by analysis of various 'components' of living which are amenable to quantitative treatment and reflect internationally accepted values or aims. The twelve components listed by the experts are: health, including demographic conditions; food and nutrition; education, including literacy and skills; conditions of work; employment situation; aggregate consumption and savings; transportation; housing, including household facilities; clothing; recreation and entertainment; social security; and human freedoms.

In addition, the report includes a series of more specific statistical indicators that should be used as a guide in measuring the various components; these indicators are chosen with the view of availability of information. In view of deficiencies of data in many countries, however, the report gives a minimum list of 'priority indicators'; it indicates how they may be obtained and adds another set of indicators to illustrate lines of further improvement.

Members of the committee recognized that an international analysis of levels of living, in terms of the components and indicators they proposed, would nevertheless fall short of giving a complete and balanced picture of the total situation. They stressed the importance of the use of descriptive materials and background information, particularly in the form of social and cultural analyses. A more direct and comprehensive assessment may be attainable by 'family living surveys' carried out by the use of sampling methods and designed to ensure international comparability.

The committee was appointed by the Secretary-General of the United Nations, jointly with the International Labour Organization and the United Nations Educational, Scientific and Cultural Organization. Members came from six different countries and represented various disciplines of social sciences and statistics. They were Prof. Raymond Firth, professor of anthropology in the London School of Economics and Political Science; Prof. Philip M. Hauser, professor of sociology in the University of Chicago; Mr. Erland v. Hofsten, chief of the Statistical Section, Social Welfare Board of Sweden; Father Louis Joseph Lebret, editor of *Economie et Humanisme*, France; Mr. O. Alexander Moraes, acting secretary-general of the Inter-American Statistical Institute of the Organization of American States; and Mr. V. K. R. V. Rao, director of the Delhi School of Economics, University of Delhi.

* Report on International Definition and Measurement of Standards and Levels of Living. (Report of a Committee of Experts convened by the Secretary-General of the United Nations, jointly with the International Labour Office and Unesco.) Pp. xii+96. (New York: United Nations; London: H.M. Stationery Office. 1954.) 0.80 dollars; 6s.; 3 Swiss francs.

MANAGEMENT COSTS

THE costs of managing industrial firms have traditionally been regarded as an incidental class of expenditure. These costs have been rising rapidly and, to-day, administrative costs have become a major expense in the operation of industrial firms. By 1948, for example, of every hundred production workers in British industrial firms, twenty were administrative employees; in 1907 the number was only eight.

Information collected by Seymour Melman shows that, in Great Britain at least, there has been no correlation between increases in administrative overheads and the growth of productivity. (*Manchester Guardian* "Survey of Industry, Trade and Finance", 1954). In the United States, on the other hand, output per worker man-hour rose by 232 per cent from 1899 to 1947 while the administrative overhead ratio increased by over 40 per cent. In Great Britain the output per worker man-hour increased by 73 per cent from 1907 to 1948 while the ratio of administrative overheads grew by 133 per cent. It has been assumed that the growth in the cost of managing necessarily yields some economy in production; there is no evidence of any relationship of this kind.

Various reasons have been put forward to explain the growth of administrative costs in view of increasing mechanization and systematization. Melman suggests that increasing costs are due to the develop-

ment of new managerial functions. Industrial management has chosen solutions to its problems which also involve the extension of formal managerial controls over ever-widening areas. The extension of managerial controls is the common feature of the growth of new functions in industrial management, including sales, accounting, cost accounting, personnel and industrial relations, as well as the addition of staff specialists trained in economics, psychology and similar disciplines. This growth in administrative staffs represents more than the trend of a business cost. It is also a social cost owing to its bearing on the effective productivity of industrial man-hours. The growth of administrative overhead will be stopped or reversed only when its development becomes the source of pressing problems to one or more of the important groups closely concerned with industrial production: that is, management, labour or government. Only then will there be a search for alternative ways of industrial decision-making which would simplify and reduce the costs of managing.

EXPERIMENTS ON THE CAUSE OF DORSIVENTRALITY IN LEAVES

IN a recent article, R. and M. Snow[1] reported experiments bearing on the cause of dorsiventrality in leaves, the results of which differed from those which I had obtained[2]. If, in my experiments, the position at which a leaf primordium was about to arise at the shoot apex of potato was isolated from the remainder of the apical meristem by a single vertical incision, the leaf which arose on the isolated panel of tissue was radially symmetrical[2], and I concluded that dorsiventrality of the leaves is induced by the activity of the apical meristem of the shoot.

It is this conclusion that the Snows question. They have repeated this experiment using potato shoots, and in only one instance, when the apex suffered from loss of turgidity after the incision was made, did the isolated leaf develop as a radial structure; in all other shoots the leaf formed was dorsiventral. However, they state that in *Epilobium hirsutum*, but not in other species, radially symmetrical leaves arose when the central part of P_1, the youngest leaf primordium, or the presumptive position of I_1, the next leaf to arise, was confined at its sides by two vertical incisions which left them continuous with the stem apex towards the centre. (In potato shoots dorsiventral leaves emerge between such pairs of incisions.) R. and M. Snow[1] suggest that a radial leaf may develop, in *Epilobium* at least, from an area which is in some way weakened, or is insufficiently large to give rise to a dorsiventral leaf. If this conclusion is valid then intrinsic factors, in the leaf primordium itself, would be operative in determining the symmetry of the leaf.

The following experiments, performed on potato apices, are relevant in that they permit a distinction between the two hypotheses of intrinsic and extrinsic determination of leaf dorsiventrality. If the centre of the apical meristem is punctured with a fine needle new leaves continue to emerge on the apical flanks. In some shoots up to eight new leaves have emerged in normal phyllotactic sequence while the puncture remained at the summit of the meristem. In every case the new leaves so formed were dorsiventral, and of normal size. In other experiments, a newly emergent P_1 primordium, or the presumptive position of I_1, together with a small adaxially situated panel of meristematic tissue not used in leaf formation, was isolated by a vertical incision from the centre of the apical meristem[2]. The isolated P_1 and I_1 primordia developed as dorsiventral leaves.

The position of the isolating incision in relation to the presumptive position of the leaf is critical. When the incision is close to the presumptive position of the leaf, the leaf is radially symmetrical[2]; when farther away, as in the experiments just described, the leaf is dorsiventral. Thus, if dorsiventrality is induced in the leaf primordium by the shoot apical meristem, the induction can be carried out by small areas of the meristem, approximately one-sixth of the meristem being sufficient[3]. This may explain the variation between results obtained by R. and M. Snow and myself. It seems probable that the incision by which they isolated the I_1 presumptive position was not close to the I_1 position, but was sufficiently far from it to include on the isolated panel some small portion of the apical meristem of the shoot, for they state[1] that in their experiments "radial leaves developed from small unoccupied areas of tissue that were left over somewhere between the isolated I_1 leaves and the stem". From the experiments described above it would be expected that I_1 would be dorsiventral when so isolated.

That the hypothesis of apical control of leaf dorsiventrality is reasonable is shown in the following series of experiments. When the I_1 presumptive position in potato is isolated from the remainder of the apical meristem, I_1 develops as a centric organ[2]. On the isolated panel, and lying on the cathodic (P_1) side of the I_1 presumptive position, is a small group of cells which were part of the apical meristem. These cells undergo differentiation and do not produce a new shoot meristem when so isolated, apparently being unable to compete successfully with the larger bulk of the terminal part of the meristem[3,4]. If, however, the emergent leaf primordia P_1 and P_2, and the terminal part of the apical meristem of the shoot are excised, leaving only the isolated I_1 panel, then the meristematic cells on the panel lateral to the I_1 presumptive position regenerate a new shoot meristem, and when I_1 emerges it does so as a dorsiventral leaf, orientated towards this new meristem, and deflected by approximately 90° from its expected orientation in an intact apex. If the excision of P_1, P_2, and the terminal part of the shoot meristem is delayed for 24–48 hours, by which time I_1 is just beginning to emerge as a centric organ, and the meristematic tissues lateral to it have begun to differentiate, no shoot meristem is regenerated on the panel, and I_1 develops as an enlarged centric organ encroaching over most of the panel surface. These enlarged centric I_1 primordia have a well-developed and extensive solenostelic vascular cylinder, and may be taller than dorsiventral leaves of the same age. They do not, therefore, appear to be the result of nutritional depletion in the leaf-forming area. It thus seems that factors extrinsic to the leaf primordium are effective in determining leaf dorsiventrality and, for dorsiventrality to occur, the leaf-forming area must be in direct continuity distally with cells of the apical meristem.

This explanation does not in its present form account for the emergence of radial leaves between two lateral incisions in *Epilobium*; however, the apical control of leaf dorsiventrality in the fern *Dryopteris aristata* has been experimentally demonstrated by Wardlaw[5] and more recently by Cutter[5],

who has shown that even young emergent leaves in this species may be caused to develop as radially symmetrical buds bearing leaf primordia when they are isolated by an incision from the apical meristem. Centric organs in potato have always been determinate in growth; nevertheless the radial symmetry of such isolated organs in members of two widely different taxonomic groups suggests an essential homology of underlying processes, involving participation of the apical meristem, in the determination of leaf dorsiventrality.

These experiments were carried out in the Department of Cryptogamic Botany, University of Manchester, and I am indebted to Prof. C. W. Wardlaw for his guidance and encouragement.

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May 4.

[1] Snow, R., and Snow, M., *Nature*, **173**, 644 (1954).
[2] Sussex, I. M., *Nature*, **167**, 651 (1951).
[3] Sussex, I. M., *Nature*, **170**, 755 (1952).
[4] Sussex, I. M., *Nature*, **171**, 224 (1953).
[5] Wardlaw, C. W., *Growth* (supplement), **9**, 93 (1949). Cutter, E. G., *Nature*, **173**, 440 (1954).

Since Dr. Sussex now considers that his views are supported by experiments in which the summit of the apex or growing-point was destroyed and dorsiventral leaves continued to be found on the apical cone below, it appears that he now thinks that the dorsiventrality of the leaves is induced in potato shoots not by the summit of the apex, but by apical tissue between the summit and the zone where leaves are determined. He seeks to explain the dorsiventral I_1 and I_2 leaves which we obtained when we isolated the presumptive areas of these leaves by supposing that our cuts were too close to the summit of the apex, so that they included some apical tissue on the isolated piece above the presumptive leaf area.

But in isolating I_1 in potato shoots we regularly placed our cuts *farther* from the summit of the apex, and closer to the I_1 than did Dr. Sussex according to his description. For he has stated[1] that his cuts extended from an edge of P_2 to an edge of P_1, as also his diagram indicates, whereas our cuts extended from the same edge of P_2, or from only just within it, to a certain point on the periphery of the apex well short of the edge of P_1. We isolated I_2 in a similar manner. So pieces such as Dr. Sussex isolated would be rather larger than ours, and would also be not entirely at the correct angular position, in our potato apices at least. For the radii through the centres of such pieces would be considerably cathodic from the normal centre of I_1—considerably closer, that is, to P_1. This is clear from the fact that P_1 and I_1 are successive leaves, and successive leaves, as we find, do not make contact in potatoes. Moreover, five of the dorsiventral leaves which developed from our isolated pieces had no axillary bud on the isolated piece, and two others had only a very small axillary bud on it, if any. This makes it unlikely that the cuts isolating these pieces were even as close to the growing point as the upper boundary of the isolated presumptive area; and it is even less likely that these cuts included on the isolated piece any tissue still closer to the summit of the apex, as Dr. Sussex suggests. (It should be explained that when the presumptive area of a leaf is isolated, its axillary bud develops either on the isolated piece or not at all: it does not develop on the axis[2].)

Also, even if in some of the other isolations a little surplus apical tissue may possibly have been included with the isolated I_1 or I_2, it seems unlikely that such tissue could induce dorsiventrality in these leaves by any physiological process. For any surplus isolated apical tissue which does not develop into an organ becomes disorganized and ceases growing. Only in a very few of the isolated pieces did we find tiny radial leaves which had apparently been formed from surplus apical tissue, and these were rather to one side of the dorsiventral isolated leaf and its axillary bud, not directly above them.

However, Dr. Sussex also states that among his own isolations of I_1 those in which the cuts were closer to the summit of the apex, so that the isolated pieces were larger, gave dorsiventral leaves instead of radials. But it should at least be considered whether the explanation of this difference is perhaps not that the larger isolated pieces included more apical tissue than the presumptive area of the leaf isolated, but that the smaller isolated pieces included less than that area, especially since, as pointed out, they appear to have been not quite correctly centred upon the angular position of I_1. For the farther the cut from the summit of the apex, the less will be the lateral extent of the piece isolated; and we have already pointed out[3] that in *Epilobium hirsutum* a lateral restriction of I_1 or of P_1 can make it develop into a radial leaf.

It is now becoming clear that isolated I_1 or I_2 presumptive areas develop very differently in different species of flowering plants. For in *Lupinus albus* we found that they developed only into dorsiventral leaves with leaflets[4]. Yet many of these leaves were very small, and most of them had no axillary bud (see, for example, ref. 4, Fig. 11). It is therefore probable that the isolated pieces from which they developed were smaller than the presumptive areas of the leaves isolated, and these pieces can scarcely have carried any surplus apical tissue.

In *Epilobium hirsutum* we find that isolated I_1 areas develop usually into radial leaves, though we have sometimes found dorsiventral leaves to develop from what were in effect isolated I_1 areas[5]. Potato shoots seem at present to be intermediate, since in them the I_1 areas which Dr. Sussex isolates develop into radial leaves, provided that the pieces isolated are not too large, while the I_1 and I_2 areas which we isolate develop into dorsiventral leaves, even when the pieces isolated are rather small.

We do not think that this discrepancy will be explained until both sets of results are illustrated with exact drawings, showing the positions of the cuts, and are also fully reported with details of the cultural conditions, the size of P_1 at the time of operation, and the variety of potato. Ours was King Edward. Nor do we think that the new experiments now reported by Dr. Sussex can profitably be discussed until they are similarly reported in detail. Only one point concerning them will be made here. The very large radial I_1's which he mentions were presumably large because their growth was freed from inhibition from the apex and from P_1 and P_2, which had all been removed, and not because they arose from specially large bases. So they do not really seem relevant.

We are continuing our experiments, and the situation seems complex. It may be necessary to

consider whether there is an apical influence orienting leaves that would have been dorsiventral even without it, as distinct from an apical induction of dorsiventrality.

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[1] Sussex, I. M., *Nature*, **167**, 651 (1951).
[2] Snow, M., and Snow, R., *New Phytol.* **41**, 13 (1942).
[3] Snow, R., and Snow, M., *Nature*, **173**, 644 (1954).
[4] Snow, M., and Snow, R., *Phil. Trans. Roy. Soc.*, B, **221**, 1 (1931).
[5] Snow, M., and Snow, R., *Phil. Trans. Roy. Soc.*, B, **225**, 63 (1935).

METAPHOSPHATE IN MYCOBACTERIAL METABOLISM

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DURING work on the effect on the metabolism of *Mycobacterium smegmatis* of some antituberculosis compounds synthesized in these laboratories, attention became directed towards the phosphorus-containing constituents of this and other Mycobacteria.

In our experiments, quantities of *M. smegmatis* (of dry weight about 40 mgm.) were extracted with 10 ml. chilled acetone for several hours, twice with ice-cold 5 per cent trichloracetic acid for a total of 8 hr., twice with 5 ml. ethanol at 19° C., and refluxed with 5 ml. of 3:1 ethanol–ether. On extraction of the residues with 10 ml. trichloracetic acid at 90° C. for 15 min., most of the remaining phosphorus went into solution, leaving a residual amount assumed to be phospho-protein. The results of one such series of extractions are given in Table 1.

Table 1. Phosphate Content of Extracts of *M. smegmatis*

Three-day old culture on Proskauer and Beck medium. 8·58 per cent nitrogen and 2·04 per cent phosphorus on dry weight basis

Method of extraction	Acetone	Cold trichloracetic acid	Ethanol, ethanol–ether	Hot trichloracetic acid	Residue
% of total phosphorus	0·6%	17·7%	3·9%	75·0% (nucleic acid phosphorus, 36·9%)	2·8%

Ultra-violet absorption studies on the hot trichloracetic acid extract showed that less than half the phosphorus in it was present as nucleic acid. The excess phosphorus could be extracted from the cells by milder agents than hot trichloracetic acid (see below), and studies were made on these extracts to determine the nature of this component. It could largely be precipitated by barium at *p*H 2·5, and was entirely hydrolysed to inorganic orthophosphate in 7 min. by *N* hydrochloric acid. This strongly suggested inorganic metaphosphate[1], which was confirmed by the fact that the extracts gave a metachromatic reaction with toluidine blue[1], and by paper chromatography[2]. The chromatographic results suggested that the inorganic metaphosphate originally had a high degree of polymerization. It is not known in what manner it is held in the cells; but from the difficulty experienced in extracting it separately from pentosenucleic acid it would appear that it is bound in a similar manner.

Three extraction methods were used in an attempt to extract the nucleic acids and the inorganic metaphosphate separately: (1) repeated extraction with trichloracetic acid at 19° C. for 12 or 24 hr. periods; (2) extraction with saturated urea at 37° C. for 24 hr.[3], followed by repeated extractions with 10 per cent sodium chloride at 19° C. for 12-hr. periods; (3) extraction for 12-hr. periods with *M*/100 bicarbonate buffer (*p*H 9) at 19° C. Each of these methods was, however, found to extract both pentosenucleic acid and inorganic metaphosphate, though at different rates. The first method was the most satisfactory, most of the pentosenucleic acid coming out in the first extract, while the inorganic metaphosphate was extracted much more slowly, and the deoxypentosenucleic acid was extracted only by hot trichloracetic acid. Table 2 illustrates this.

Table 2. Extraction of Pentosenucleic and Deoxypentosenucleic Acids and Inorganic Metaphosphate from *M. smegmatis* cell residues (initially containing 3·00 mgm. Nitrogen) after Extraction with Acetone, Cold Trichloracetic Acid, Ethanol and Ethanol–ether

Method of extraction	First extraction: trichloracetic acid at 19° C. for 24 hr.	Second extraction: trichloracetic acid at 19° C. for 24 hr.	Third extraction: trichloracetic acid at 19° C. for 24 hr.	Fourth extraction: trichloracetic acid at 90° C. for 15 min.
Metaphosphate phosphorus	92·1 μgm.	97·7 μgm.	66·1 μgm.	98·0 μgm.
Pentosenucleic acid phosphorus	121·1 μgm.	49·8 μgm.	13·3 μgm.	None
Deoxypentose nucleic acid phosphorus	None	None	Trace	32·0 μgm.

Considerable amounts of pentose-containing substances (presumably polysaccharides[4]), and smaller amounts of substances estimating as deoxyribose by the Dische reaction, were present in the extracts, especially in the hot trichloracetic acid extract. Consequently, in differentiating pentosenucleic and deoxypentosenucleic acids, use had to be made of the difference in their absorption curves after heating in trichloracetic acid[5]. Afterwards, the use of the above trichloracetic acid extraction at 19° C. and then 90° C. provided a satisfactory method for the separation, and thus for the estimation, of the two nucleic acids in *M. smegmatis*. Since it was not practicable to separate either of the nucleic acids from inorganic metaphosphate, in studies with phosphorus-32 it was necessary to calculate their specific activities indirectly, having determined the content of deoxypentosenucleic acid (or pentosenucleic acid) and inorganic metaphosphate in an extract, and having determined the specific activity of the latter, isolated as the barium salt by precipitation at *p*H 2·5. The Schmidt–Thannhauser method did not give reliable results with this organism.

Similar results were obtained for the phosphorus components of *M. tuberculosis* RIRa (Table 3).

The presence of metaphosphate has been recorded in a number of lower organisms, for example, yeasts[6], corynebacteria[7,8], moulds[10] and algae[9], and its association with the metachromatic granules in these organisms has been pointed out. The subject has been reviewed recently[10]. After the work described in the present communication had been done, a paper by Ruska *et al.*[11] came to our attention in which the

Table 3. Phosphate Content of Fractions of *M. tuberculosis* RIRa

14-day old culture on Lowenstein medium

Fraction	Soluble in cold trichloracetic acid	Lipide	Pentose nucleic acid	Deoxypentose nucleic acid	Inorganic metaphosphate	'Phosphoprotein'
% of total phosphorus	27·0%	6·0%	29·8%	6·0%	27·0%	5·3%

presence of metaphosphate in *M. avium* was demonstrated, and its association with the polar granules in this organism shown.

The content of metaphosphate in *M. smegmatis* increases with the age of the culture, and the metachromatic granules correspondingly increase in frequency and size (Table 4). It has been found possible to cause the inorganic metaphosphate content to increase to a much higher level than was found normally. When lightly ground material from a 3- or 4-day old culture in Proskauer and Beck medium[12] was aerated at 37° C. in the same medium without the nitrogen source (asparagine), over a period of several hours only a very slight increase in the inorganic metaphosphate content of the cells occurred. If, however, 2·5 per cent tetrahydrofurfuryl alcohol was added, the inorganic metaphosphate per cell was doubled in 3 hr. and was increased threefold in 5 hr. The granules grew to an inordinate size. Studies using phosphorus-32 showed that increased formation of inorganic metaphosphate took place and consequently that the effect was not due to decreased utilization.

Table 4. Variation of Composition of *M. smegmatis* with Age

Age of culture	2 days	3 days	4 days	6 days
mgm. nitrogen/ mgm. phosphorus	5·52	5·13	4·60	3·41

No other striking changes in cell composition or behaviour were observed. Respiration was scarcely affected by tetrahydrofurfuryl alcohol under these conditions, although in the absence of other substrates it caused an increased respiration-rate. Similar, but much smaller, effects on metaphosphate content have been obtained with both 2 per cent ethanol and 2 per cent tetrahydrofuran.

When the cells were aerated at 37° C. in the full Proskauer and Beck medium for five hours, the dry weight, total nitrogen, respiration, acid-soluble phosphorus, and pentosenucleic and deoxypentosenucleic acids increased, as expected. (The deoxypentosenucleic acid increased more slowly than the pentosenucleic acid at first—an increase in the latter was apparent after 1 hr., in the former only after 3 hr.; after five hours, the pentosenucleic acid had increased by a factor of 1·73, deoxypentosenucleic acid by a factor of 1·34; but by this time the rate of increase of the latter exceeded that of the former.) There was a slight falling off in the inorganic metaphosphate content which indicated a distinct drop in the amount per cell. The granules became smaller and partly hidden in a cytoplasm which now stained deeply with neutral red. When the experiment was carried out under the same conditions, but with the addition of 2·5 per cent tetrahydrofurfuryl alcohol, dry weight, nitrogen, respiration and pentosenucleic acid all increased at about the same rate as before, but acid-soluble phosphorus and deoxypentosenucleic acid increased more slowly. The inorganic metaphosphate showed a striking increase, almost as great as that in the absence of nitrogen. There was a corresponding increase in the size of the granules. Thus the novel situation was obtained in which actively growing cells, which normally allow their inorganic metaphosphate to drop, were instead increasing it far beyond the level normally attained in old cultures.

No stimulation of formation of inorganic metaphosphate in yeast was caused by tetrahydrofurfuryl alcohol.

The function of inorganic metaphosphate in the organisms in which it occurs is by no means clear. It is obviously a reservoir of phosphate, and has been shown to be partly used up during growth, and more completely in phosphate-starvation, and to be rapidly replaced when phosphate was provided[1,9]. The view was held[9,10] that the high inorganic metaphosphate content of 'resting' cells was due to the fact that it was not being used for synthetic purposes, as it was in growing cells. We have found this pattern to be followed up to a point in *M. smegmatis*, but the finding that in the presence of tetrahydrofurfuryl alcohol cell growth can occur without any substantial reduction in a very rapid rate of inorganic metaphosphate accumulation would seem to show that, in this organism at least, the pattern is more intricate than that suggested above. Our results suggest that inorganic metaphosphate is not rapidly used up by growing cells.

It seems open to doubt that inorganic metaphosphate exists only as a reservoir of phosphate, since it is unlikely that cells would keep a supply of phosphate sufficient to last for a couple of generations. It has been suggested[9] that, as a form of 'high-energy' phosphate[14], inorganic metaphosphate forms an energy reservoir. The energy stored in this form, however, would seem only to be equal to that liberated by cell respiration in about a minute. Attempts made in this laboratory to show that inorganic metaphosphate could provide energy for synthesis have not so far been successful.

Thus this work still leaves without a definite answer certain important questions. What is the main function of inorganic metaphosphate in mycobacterial and other cells? Is its high energy content of importance? In addition, new questions are raised. How does tetrahydrofurfuryl alcohol stimulate the formation of inorganic metaphosphate to such an astonishing extent, and interfere with the normal cycle of change of the metaphosphate content with the age of cultures?

Details of this work will be published elsewhere.

In conclusion, we wish to thank Dr. V. C. Barry for encouragement and for stimulating and critical discussion; Prof. E. J. Conway, of University College, Dublin, for providing facilities for work with radioactive phosphorus; and Arthur Guinness Son and Co., Ltd., for generously providing financial assistance.

[April 13.

[1] Wiame, J. M., *J. Biol. Chem.*, **178**, 919 (1949).
[2] Crowther, J. P., *Nature*, **173**, 486 (1954).
[3] Jones, A. S., *Biochim. et Biophys. Acta*, **10**, 607 (1953).
[4] Stacey, M., and Kent, P. W., "Adv. Carb. Chem.", **3**, 311 (1948).
[5] Logan, J. E., Mannell, W. A., and Rossiter, R. J., *Biochem. J.*, **51**, 470 (1952).
[6] Wiame, J. M., *Biochim. et Biophys. Acta*, **1**, 234 (1937).
[7] Bringmann, G., *Zbl. f. Bakt., I Org.*, **156**, 493 (1950).
[8] Konig, H., and Winkler, A., *Naturwiss.*, **35**, 136 (1948).
[9] Stich, H., *Z. Naturforsch.*, **8b**, 36 (1953).
[10] Winkler, A., VIth Int. Congr. Microbiol. Symposia—Bacterial Cytology, 37 (1953).
[11] Ruska, H., Bringmann, G., Neckel, I., and Schuster, G., *Z. wissensch. Mikroscopie*, **60**, 425 (1952).
[12] American Trudeau Society, *Amer. Rev. Tuberc.*, **61**, 274 (1950).
[13] Mann, T., *Biochem. J.*, **38**, 339, 345 (1945).
[14] Meyerhof, O., Shatas, R., and Kaplan, A., *Biochim. et Biophys. Acta*, **12**, 121 (1953).

LETTERS TO THE EDITORS

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Oxygen and Hæm in Invertebrates

THE quantity of hæmoglobin in solution in the blood of *Daphnia* is inversely proportional to the dissolved oxygen content of the water in which the animals live[1,2]. In the course of a few days *Daphnia* can change in tint from almost colourless to red, or the reverse, by the synthesis or breakdown of hæmoglobin. This occurs, too, in other branchiopod Crustacea (for example, Estheria, Apus, *Artemia*). Since a gain of blood-hæmoglobin with fall of external oxygen pressure is known also in man at high altitudes and fishes in poorly aerated water, one may ask if it occurs in all animals with hæmoglobin.

One of the most familiar invertebrate animals with abundant hæmoglobin in solution in the blood is the larva of the midge *Chironomus*. It lives in a mucous tube embedded in mud at the bottom of ponds. Keeping larvæ with well-aerated and poorly aerated water above the mud was found to have no influence on their hæmoglobin content. This may have been because the larvæ control the oxygen content of the water in their tubes; they draw in water by undulatory body movements, which are intermittent, the intervals becoming longer when the water is well aerated[3]. An attempt was therefore made to keep the larvæ without mud, but it failed because larvæ kept thus die in a few days. Young larvæ, however, freshly hatched from the egg, can live without mud. Fed on *Chlorella*, they grew and made mucous tubes, but frequently left them to swim in the water. These young larvæ formed more hæmoglobin in poorly than in well-aerated water. The partially and fully grown larvæ of another midge, *Anatopynia varia* (Fabr.), which make no tubes, also had more hæmoglobin in poorly aerated water.

The most familiar mollusc with hæmoglobin in solution in its blood is the ramshorn pond snail, *Planorbis corneus* (L.). Keeping adults for a month in water of high or low oxygen content had no effect on the redness of the blood; but newly hatched young reared in poorly aerated water became, in less than a month, redder than those grown in well-aerated water. It was not, however, found possible to influence the hæmoglobin content in the blood of annelid worms by changes in external oxygen concentration.

In the vertebrates hæmoglobin is found in muscle cells as well as in the blood. In invertebrates hæmoglobin occurs not only in blood and muscle, but also in nerve, fat and tracheal cells, cœlomic corpuscles, ova, parenchyma of rhabdocœles and bodies of Protozoa[4]. In mammals it is uncertain whether there is an increase in muscle hæmoglobin at high altitudes[5], but muscular exercise has this effect[6], owing perhaps to local oxygen deficiency. It was found that hæmoglobin increases and decreases in concentration in muscles and nerve ganglia of cladoceran and conchostran Crustacea just as it does in the blood, in response to paucity or sufficiency of oxygen in the environment. There was, however, no such effect of oxygen on the hæmoglobin content of pharyngeal muscles in the pond-snail *Physa*, or of the parenchyma in the rhabdocœle worm *Phaenocora*.

Thus, among the invertebrates, in some but not all instances, hæmoglobin of blood or tissue cells fluctuates in quantity inversely as the oxygen pressure in the environment. Finally, cytochrome, detectable with the microspectroscope in muscles of *Daphnia* and Conchostraca, increases and decreases in concentration, like the hæmoglobins of blood, muscle and nerve, as the oxygen in the water decreases or increases. In mammals, too, an increase in the quantity of cytochrome in muscle occurs in response to a low atmospheric pressure[7]. It is curious, however, that the increase of cytochrome in mammals and Crustacea in response to diminished oxygen is the reverse of what occurs in baker's yeast, where the synthesis of cytochromes *a*, *b* and *c* is stimulated by air and inhibited by its absence[8,9].

A full account of this work will be published in the *Proceedings of the Royal Society*.

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[1] Fox, H. Munro, *Proc. Roy. Soc.*, B, **135**, 195 (1948).
[2] Fox, H. Munro, and Phear, E., *Proc. Roy. Soc.*, B, **141**, 179 (1953).
[3] Walshe, B. M., *J. Exp. Biol.*, **27**, 73 (1950).
[4] Keilin, D., and Ryley, J. E., *Nature*, **172**, 451 (1953).
[5] Grant, W. C., and Root, W. S., *Physiol. Rev.*, **32**, 449 (1952).
[6] Lawrie, R. A., *Nature*, **171**, 1069 (1953).
[7] Delachaux, A., and Tissières, A., *Helv. Med. Acta*, **13**, 333 (1946).
[8] Chin, C. H., *Nature*, **165**, 926 (1950).
[9] Ephrussi, B., and Slonomski, P. P., *Biochim. Biophys. Acta*, **6**, 256 (1950).

Passage of Glucose and Glycerol across the Red Cell Membrane

DURING recent years, increasing evidence has accumulated indicating that the passage of glucose across the human red cell membrane and of glycerol across the human and rabbit membranes is not a process of simple diffusion. The results of Wilbrandt and Rosenberg[1], Lefevre[2] and Widdas[3] show that the kinetics are not those of a simple diffusion process, and the effect of enzyme inhibitors indicates that at least specific adsorption sites are involved. The work of Lefevre[4] showed the inhibiting action of —SH agents; for example, *p*-chloromercuribenzoates, iodine and mercuric ions on glucose and glycerol transfer, the work of Jacobs and Corson[5] showed the inhibition of glycerol transfer by copper, and Wilbrandt[6] showed that glucose penetration is inhibited by lachrymators whereas glycerol remains unaffected. The passage of both glycerol and glucose is inhibited by phloridzin[4].

Though at first sight it would appear that the process is an active transfer involving an enzymic reaction providing energy other than thermal agitation, this is not necessarily so; and the process is perhaps better regarded as facilitated diffusion[7]. In this case the process differs from simple diffusion in being restricted by both structural and steric factors, and energy may be required for maintenance of structural units. It has been pointed out[7] that the distinction between active transport and facilitated diffusion may be one of degree only.

The present investigation was an attempt to study more closely the relationship between enzyme inhibition and the inhibition of facilitated diffusion by using irreversible inhibitors of the latter and showing strict parallelism to enzyme inhibition. The irreversible inhibitor chosen was 2–4 dinitrofluorobenzene. This substance was developed as a reagent for protein end-groups by Sanger[8] and also as a cytochemical agent by

Table 1

Inhibitor or added substance	Type of red cell	Effect on glucose		Effect on glycerol		Effect on sodium and potassium ions
		Entry	Exit	Entry	Exit	
Dinitrofluorobenzene	Rabbit			Nil	Nil	Very slight inhibition
	Human	Inhibits	Inhibits			
Dinitrobenzene	Human	Nil				Nil
Dinitrochlorobenzene	Human	Nil				Nil
Dinitrophenol	Human	Nil				
Diazonium hydroxide of *p*-nitraniline	Human	Nil	Nil	Nil	Nil	Apparent loss of potassium ions and gain of sodium ions
	Rabbit					
Phloridzin	Human	Inhibits	Inhibits			
	Rabbit			Inhibits		Nil
Eserine	Human	Nil	Nil			
	Rabbit			Nil	Nil	Potassium ions apparently lost slowly

Danielli[9]. It can react with —SH groups, —NH_2 groups and tyrosine. So as to make the information more specific, a second inhibitor was used—the diazonium hydroxide of *p*-nitraniline. This substance combines irreversibly with histidine, tyrosine and tryptophan, but not with —SH groups.

The effect of these two compounds and related substances on the entry and exit of glucose and glycerol into human and rabbit cells is summarized in Table 1.

The results are a strong indication that —SH groups are involved in the entry and exit of glucose but not in the passage of glycerol. It also appears as though tyrosine, tryptophan and histidine are not involved in either case.

In a consideration of the enzyme to which the dinitrofluorobenzene was attached, two possibilities were immediately suggested, namely, the esterases cholinesterase and phosphatase. The possible role of cholinesterase was considered because of the importance of this enzyme in the permeability of cells to sodium and potassium[10]. Preliminary investigations on the effect of the inhibitor eserine on the penetration of glucose and glycerol indicate, however, that cholinesterase is not involved in these cases. The second enzyme, phosphatase, has been thought to be of importance in glucose transfer in the red cell because of the inhibiting action of phloridzin and because of the similarity to glucose transfer in the kidney and intestine, where phosphatase is often considered to be the enzyme involved. The facilitated diffusion of glycerol is also inhibited by phloridzin, but as dinitrofluorobenzene inhibits the passage of glucose and not that of glycerol, different mechanisms for the two substances are probable. Thus, further work on the importance of phosphatase is indicated.

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[1] Wilbrandt W., and Rosenberg, T., *Helv. Physiol. Acta*, **9** C.86 (1951).
[2] Lefevre, P. G., and Davies, R. I., *J. Gen. Physiol.*, **34** 515 (1951).
[3] Widdas, W. F., *J. Physiol.*, **118**, 23 (1952).
[4] Lefevre, P. G., *J. Gen. Physiol.*, **31**, 505 (1948).
[5] Jacobs, M. H., *J. Cell. Comp. Physiol.*, **4**, 161 (1934).
[6] Wilbrandt, W., Symp. Soc. Exp. Biol., **8** (in the press).
[7] Danielli, J. F., Symp. Soc. Exp. Biol., **8** (in the press).
[8] Sanger, F., *Biochem. J.*, **39**, 507 (1945).
[9] Danielli, J. F., Cold Spring Harbor Symp., **14**, 32 (1950).
[10] Grieg, M. E., and Holland, W. C., *Arch. Biochem.*, **26**, 151 (1950).

Independence of Delayed Fertilization and Spontaneous Triploidy in Mouse Embryos

In the early mouse embryo, spontaneous[1] or experimentally induced[2] triploidy is thought to arise by fertilization of an unreduced diploid egg by a haploid normal sperm. The possibility has not been wholly excluded that the extra set of chromosomes is derived instead from the male[3]—for example, double fertilization or diploid sperm—or after delayed fertilization[4]. In the rat and rabbit, Austin and Braden[5] showed that experimentally delayed fertilization causes polyspermy; in the rat, chromosome counts at the first cleavage division showed that some dispermic eggs were triploid. It was suggested[6] that some of the spontaneously triploid mouse embryos might have arisen in this way, and not by doubling of the maternal chromosomes.

To investigate this possibility in the mouse, œstrus and timed ovulation were induced by the method of Runner and Gates[7]. Three- to four-week old hybrid mice were brought into œstrus by two intraperitoneal injections, the first a priming injection of 2 I.U. of pregnant mare's serum, and then 36 hr. later an ovulating dose of 2 I.U. of chorionic gonadotrophin (kindly supplied by Organon Laboratories, Ltd.). With the time of ovulating injection referred to as zero hour, egg recoveries from a large series of mice showed that ovulation was initiated and in all probability completed between 11 and 13 hr. The injected females were then exposed to males either at 9–12 hr. (little or no imposed delay in fertilization), or at 17–22 hr. (delayed fertilization). Coitus was scored by examination for vaginal plugs at 1- or 2-hr. intervals. Females without a vaginal plug at 23 hr. were left overnight with males (further delay in fertilization). In each daily series, some mice were subjected to delayed fertilization, some to undelayed, and a few were sacrificed at 11 and 12 hr. without mating, to detect any day-to-day variation in hormonal stimulation and time of ovulation. Eggs were recovered from all mated females at 3½ days from the estimated ovulation time. Fertilized eggs (morulæ and blastocysts) were analysed chromosomally as Feulgen squash preparations.

Absence of triploid embryos in mature females. Normal matings of sexually mature females of the same strains as used before indicated the level of spontaneous triploidy in uninjected mice. Of the 152 analysable embryos from 59 females, 148 were diploid and none triploid.

Immature females—ovulation time. Autopsies showed that ovulation had not begun by 10 hr. after the ovulating injection (16 mice), nor by 11 hr. (18 mice). Of thirty-eight mice autopsied at 12 hr.,

thirty-three (87 per cent) had ovulated. Of the mice autopsied after 13, 14 and 18 hr. (twenty mice per group), all but one had ovulated. There was no significant difference in the mean numbers of ova per female between these last three groups, nor did they differ significantly from the mean number of eggs, fertilized and unfertilized, recovered at 3½ days in the main experiment. The mean number of ova recovered from ovulated mice at 12 hr. was one-half the number recovered at each later time. These results indicate strongly that ovulation is initiated soon after 11 hr., reaches a half-way mark at 12 hr., and is completed by 13 hr. from the time of the ovulatory injection. These limits are more narrowly defined, but within the same time-range as previously reported with different material and half our priming injection[8].

Immature females—incidence of triploid embryos after undelayed fertilization. Among the thirty-eight immature females placed with males at 9–12 hr. after ovulatory injection, nineteen exhibited vaginal plugs between 10–13 hr. (mean 11½ hr.). This group represented an 'immature control' series without imposition of delayed fertilization. Of the analysable embryos recovered at 3½ days, 127 were diploid; three (2·4 per cent) were triploid—two from a 10-hr. plug, one from an 11½-hr. plug. The high yield of eggs (mean, forty-three per female) is characteristic of superovulation in these immature hybrid mice. The relatively low number of analysable eggs is accounted for by those uncleaved, lost during preparation or not analysable.

Immature females—incidence of triploid embryos after delayed fertilization. Of the females exposed to males 17–22 hr. after ovulatory injection, seventeen showed vaginal plugs at 18–24 hr. (mean 19 hr. 20 min.). If 1½–3 hr. is allowed for sperm transport, sperm ripening, and time for penetration of the ovum, and with ovulation at 11–13 hr., these seventeen mice show a delayed fertilization of at least 5½ hr. and at most 16 hr. Of the analysable embryos, sixty-four were diploid and two (3 per cent) triploid, the percentage being higher than in immature controls, but not significantly so. Of females showing no vaginal plugs by 23 hr., six of those left overnight with males exhibited plugs the next morning. There can be little doubt that fertilization was substantially delayed in this group. An obvious retarded development and reduced fertilization-rate in eggs after late insemination gave internal evidence that fertilization had really been delayed. Yet of the twenty-three analysable embryos, twenty-two were diploid and none triploid, the incidence of triploidy being this time below that in immature controls, though not significantly so.

In summary (see Table 1), this experiment indicates, first, a slight non-significant incidence of triploidy in embryos from superovulated immature hybrid mice. Secondly, delayed fertilization by 5½ hr. or more has not resulted in an increased incidence of triploid embryos. Little or none of the spontaneous triploidy[1,3] reported among mouse embryos seems to be explained by Austin and Braden's suggestion of delayed fertilization. Either, contrary to their interesting findings in the rat and rabbit, delayed fertilization in the mouse does not lead to polyspermy; or polyspermic eggs which may have occurred did not become transformed into triploids; or triploids of such origin cannot be scored at 3½ days. Further, in experimentally induced triploidy in the mouse[2], delayed fertilization may be ruled out as a major intermediary between the stimulus imposed and the observation of triploids at 3½ days.

Table 1. Mice Examined and Eggs Recovered in Adult Controls and in Injected Immature Females With or Without Delayed Fertilization

	Adult ♀♀ controls	Immature ♀♀ with undelayed fertilization (mean 11½ hr. from ovulatory injection until plug seen)	Immature ♀♀ with delayed fertilization (mean 19½ hr. from ovulatory injection until plug seen)	Immature ♀♀ with extreme delay in fertilization (>20<37 hr. from ovulatory injection until plug seen)
Females used	59	19	17	6
Females with eggs	55	19	17	6
Females with analysable embryos	45	17	15	3
Females with triploid embryos	0	2	2	0
Egg classification				
Uncleaved, lost and not analysable	377	678	715	294
Diploid	148	127	64	22
Triploid	0	3	2	0
Others (tetraploid, aneuploid and chromosomal mosaics)	1+3?	1+2?	1+2?	1

We are indebted to Prof. C. H. Waddington for facilities for, and interest in, this work, which was carried out with financial support from the Agricultural Research Council (R. A. B.), and from the Jackson Memorial Laboratory, Bar Harbor, Maine, U.S.A. (A. H. G.).

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[1] Beatty, R. A., and Fischberg, M., *J. Genetics*, **50** 345 (1951).
[2] Fischberg, M., and Beatty, R. A., *J. Genetics*, **50**, 455 (1951).
[3] Fischberg, M. and Beatty, R. A., *Evolution*, **6**, 316 (1952).
[4] Beatty, R. A., *Anim. Breed. Abstr.*, **19**, 283 (1951).
[5] Austin, C. R., and Braden, A. W. H., *Aust. J. Biol. Sci.*, **6**, 674 (1953).
[6] Austin, C. R., and Braden, A. W. H., *Nature*, **172**, 82 (1953).
[7] Runner, M. N., and Gates, A. H., *Nature* [**174**, 222 (1954)].
[8] Runner, M. N., and Palm, J., *J. Exp. Zool.*, **124**, 303 (1953).

A Possible Endocrine Mechanism controlling Locust Pigmentation

It has been suggested that the changes in the coloration of locusts associated with swarming may be partly controlled by an endocrine mechanism[1], although until recently no experimental work has been available to support this view[2].

It is interesting to note, therefore, that injection of blood obtained from fourth-instar crowded (phase *gregaria*) hoppers of *Schistocerca gregaria* (Forsk.) into isolated-reared (phase *solitaria*) hoppers induces an increased black pattern and yellow or yellow-green background pigmentation in the next instar, that is, a change towards a *gregaria*-type coloration. When *solitaria* hoppers are injected as controls with an equal volume of insect Ringer or Tyrode's solution, or with blood from other *solitaria* hoppers, they retain the normal green background pigmentation with small amounts of brown or black melanin pattern.

The injection of *gregaria* blood into *gregaria* hoppers also produces no response.

It has been found that the degree of response to blood injections is dependent on the age of the insect; thus, maximum change in both pattern and background is obtained when mid-fourth-instar hoppers are injected. The compound (or compounds) involved in the change is not inhibited by acid or alkali and resists heat, though not prolonged boiling; its properties are therefore similar to those of other known insect hormones[3]. Ether-extraction of the *gregaria* blood suggests that the compound is ether-soluble, since this fraction was found to be as active in inducing changes in *solitaria* coloration as the non-treated blood, while the ether-insoluble fraction had little effect.

The present work, while tending to supply evidence of a blood-borne factor controlling phase pigmentation, does not preclude the possibility of genetical and environmental factors combining to determine the final type of the coloration, but tends to elucidate the physiological mechanism by which such factors are co-ordinated within the insect. The variation in the degree of colour change, according to the age of the hopper, emphasizes the importance of the relationship between hormone and tissue response in the system as a whole.

I wish to thank Prof. J. F. Danielli of King's College, London, and Drs. B. P. Uvarov and T. H. C. Taylor of the Anti-Locust Research Centre, for advice and criticism of this work, which is being done with a grant from that Centre.

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[1] Hertz, M., and Imms, A. D., *Proc. Roy. Soc.*, B, **122**, 281 (1937). Hanström, B., "Hormones in Invertebrates" (Clarendon Press, Oxford, 1939). Chauvin, R., *Ann. Soc. Ent. Fr.*, **110**, 133 (1941).
[2] Joly, P., and Joly, L., *Ann. Sci. Nat., Zool.*, ii. **15**, 331 (1953).
[3] Timon-David, J., *Biol. Bull. Supp.*, **33**, 87 (1948).

Apparent Induced Enzyme Formation due to Co-enzyme Deficiency

Previous studies by Happold and Hoyle[1] and Dolby, Hall and Happold[2] made it appear certain that the enzyme tryptophanase was induced in cultures of *Escherichia coli* only in response to the presence of tryptophan in the medium in which the cell was grown. It was not developed in a complete amino-acid medium which also contained glucose but, as was shown by Evans, Handley and Happold[3], the tryptophan content of the medium remained unchanged, so that it was presumed that the fermentation of the carbohydrate gave conditions of culture comparable to the total absence of tryptophan in the medium. These studies were made either with enzyme preparations or with washed cells incubated with the substrate in the presence of toluene, which procedure reduced tryptophanase activity only slightly but did render the cells non-viable.

In recent experiments, in order to study different relationships, we have carried out a great number of experiments with washed cells which were still viable and which had been grown with forced aeration at 37° C. for 16 hr. on a basal medium of sodium succinate, 20 gm.; ammonium sulphate, 1 gm.; potassium sulphate, 1 gm.; sodium sulphate, 0·5 gm.; potassium dihydrogen phosphate, 9 gm. per 975 ml. distilled water, to which after sterilization and adjustment to *p*H 7·0, 25 ml. of a sterile solution of magnesium sulphate ($MgSO_4.7H_2O$) (10 per cent w/v) was added.

When grown on this medium, harvested and incubated with tryptophan, certain strains of *Escherichia coli*, particularly those recently isolated, showed a lag of 15–40 min. before indole production occurred, whereas others showed an immediate but weak tryptophanase activity which remained for some considerable time. Neither type of cell suspension produced a high tryptophanase activity within the space of two and sometimes three hours. The use of amino-acid media which were free from tryptophan also resulted either in cells which showed initial lag or which possessed tryptophanase activity *ab initio*; such cells, however, either developed or possessed greater enzyme activity than did those cells which had been grown on the previously described basal medium.

In the present communication, we record results of experiments performed two years ago relating to this problem of lag since we feel they throw light upon current studies in related fields. Tryptophanase is an enzyme dependent upon pyridoxal phosphate; any deficiency in the synthesis of pyridoxine derivative by the cells might produce a lag in indole formation. Similarly, a competitive utilization of pyridoxal phosphate by the amino-acid decarboxylases, which are so highly active in *Escherichia coli* grown in the amino-acid medium containing glucose, could also result in a lag in indole formation when such cells were incubated with tryptophan. We had previously tried the effect of adding pyridoxal phosphate to cells grown in the presence of glucose, with negative results, but unfortunately had not associated these experiments with our findings[3] that the glucose-induced lag was markedly reduced by reducing the concentration of sodium ions and increasing that of potassium ions in our system. The recent findings of Happold and Struyvenberg[4] that ammonium ions are better as activators of the tryptophanase system than potassium ions, and the latter than rubidium ions, changes the picture. Lichstein, Gunsalus and Umbreit[5] have shown that *S. faecalis* grown in media supplying DL-alanine instead of vitamin B_6 did not carry out transaminations; Gale[6] that such cells did not decarboxylate tyrosine unless pyridoxal or pyridoxal phosphate was added; Holden, Feirman and Snell[7] that cells grown in the presence of D-alanine contained not more than 5 per cent of the amount of vitamin B_6 present in organisms grown in the absence of D-alanine. Separate additions of L-alanine and DL-alanine to a concentration of 10^{-3} *M*, of DL-phenylalanine to 5×10^{-4} *M* and of tryptophan to 3×10^{-4} *M*, were made to the basal medium in order to test the effect of each of these additions in the induction of the tryptophanase system.

The cells from such cultures have been separated from the culture medium, washed in *M*/75 phosphate buffer *p*H 7·8 and resuspended in a further portion of the buffer solution. The cellular mass of the suspensions was standardized by determining the dry weight of 1-ml. samples of all suspensions tested; they varied from 2·5 to 6 mgm. per ml. In order to test their ability to produce indole from tryptophan (tryptophanase activity) a number of replicates were always prepared which contained 1 ml. of cell suspensions and 2 ml. *M*/75 phosphate buffer *p*H 7·8 (with or without 3 μgm. pyridoxal phosphate) and which were incubated at 37° C. for 10 min., after

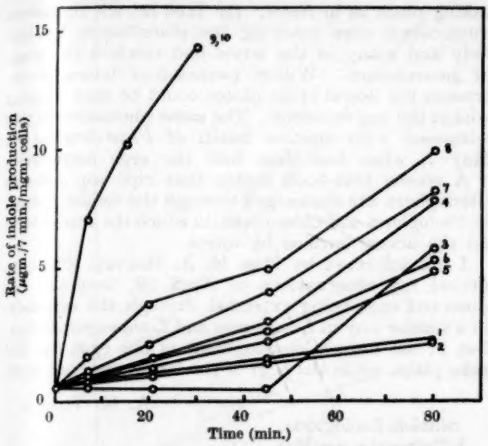

Fig. 1. Effect of the addition of certain amino-acids to a basal medium on the tryptophanase activity of cells of *E. coli* grown thereon.
Indole production per mgm. dry wt. of cells of *Escherichia coli*. 1, Cells from basal medium; 2, cells from basal medium + 3 μgm. pyridoxal phosphate; 3, cells from basal medium + 10^{-3} *M* DL-alanine; 4, cells from basal medium + 10^{-3} *M* DL-alanine + 3 μgm. pyridoxal phosphate; 5, cells from basal medium + 10^{-3} *M* L-alanine; 6, cells from basal medium + 10^{-3} *M* L-alanine + 3 μgm. pyridoxal phosphate; 7, cells from basal medium + DL-phenylalanine; 8, cells from basal medium + DL-phenylalanine + 3 μgm. pyridoxal phosphate; 9, cells from basal medium + tryptophan; 10, cells from basal medium + tryptophan + 3 μgm. pyridoxal phosphate

which 2 μgm. l-tryptophan in 1 ml. buffer (also at 37° C.) was added. The indole produced was then measured at intervals from 7 min. to 180 min. after the onset of incubation. The results are presented in Fig. 1.

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[1] Happold, F. C., and Hoyle, L., *Biochem. J.*, **29** 1918 (1935); *Brit. J. Exp. Path.*, **17**. 136 (1936).
[2] Dolby, D. E., Hall, D. A., and Happold, F. C., *Brit. J. Exp. Path.*, **33**, 304 (1952).
[3] Evans, W. C., Handley, W. R. C., and Happold, F. C., *Biochem. J.*, **35**, 207 (1941).
[4] Happold, F. C., and Struyvenberg, A., *Biochem. J.* (in the press).
[5] Lichstein, H. C., Gunsalus, I. C., and Umbreit, W. W., *J. Biol. Chem.*, **161**, 311 (1945).
[6] Gale, E. F., "Advances in Enzymology", **6**, 1 (1946).
[7] Holden, J. T., Feirman, C., and Snell, E. E., *J. Biol. Chem.*, **178**, 789 (1949).

A Virus associated with Canine Encephalomyelitis

We have recently isolated from the tissues of a dog dying of encephalomyelitis a transmissible agent which appears to differ in several significant respects from the known etiological agents of canine encephalitis.

The natural case was a four months old fox terrier which developed nervous symptoms and died one month after distemper prophylaxis by the virulent virus – hyperimmune serum technique. It was not examined clinically. Histopathological examination revealed an acute demyelinating encephalitis without evidence of formation of inclusion bodies.

The experimental disease is characterized clinically by a continuous high fever with the subsequent development of various symptoms referable to the central nervous system. Tremor, weakness, ataxia, disturbed reflexes and epileptiform seizures have been seen. The histopathological lesions are those of a demyelinating encephalomyelitis. In addition, in one case there was an interstitial pneumonia. In no case have inclusion bodies been found in the brain or elsewhere. The sera of experimentally infected puppies (including one which survived forty-nine days *post inoculationem*) have shown no development of complement-fixing antibodies when tested against canine distemper virus and contagious canine hepatitis virus.

The experimental disease has been set up by the inoculation of tissue suspensions treated with 500 units of penicillin and 100 micrograms of streptomycin per ml. administered in intrathecal and intraperitoneal routes. In no case has any evidence of cultivable bacteria been found. Attempts are being made to cultivate the agent in the chick embryo; the results to date are equivocal.

The findings reported herein are of interest as they tend to incriminate a virus or virus-like agent distinct from those known to be capable of causing canine encephalitis. Much work will be required before such a hypothesis can be adequately supported; meanwhile, it is believed that the subject of the etiology of canine encephalitis is of sufficient general interest to warrant publication of these preliminary observations.

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Preservation of Bacteria

Bacteria may be preserved by drying suspensions either from the frozen or from the liquid state. Of these two methods, the former, particularly in the form of centrifugal freeze drying[1], has been widely used because of its efficiency and convenience.

A method which differs from previous ones and which appears to be worth serious investigation is at present being studied. In outline, it consists of dehydrating the viscous product which results when a small volume of bacterial suspension is incorporated in a mass of previously freeze-dried material.

The results shown in the table were derived from some early experiments with this method.

Organism	Survival (per cent) 1	2	4	8 months
Sh. flexneri	93	100	88	82
Salm. stanley	91	82	85	70
Salm. typhi	87	87	91	80
Str. viridans	80	80	69	63

Glass ampoules of 8 ml. capacity were found to be convenient for quantitative studies. A mixture of 6 per cent peptone (Evans) and 1 per cent soluble starch (B.D.H., 'Analar') was sterilized by autoclaving and dispensed into the ampoules in 1·5 ml. quantities. After freezing the mixture at − 20° C. for at least 5 hr., it was dried *in vacuo* for *c.* 18 hr., the water vapour being condensed on a refrigerated coil at − 40° C. The solids were left in the form of compact cylindrical plugs *c.* 13 mm. in diameter and *c.* 10 mm. in depth. The ampoules were stored in air-tight jars.

The manifold on which the inoculated ampoules were dried was a simple brass model with side-arms

of rubber tubing which could be opened or closed with steel spring clips. Before the ampoules were inoculated, the manifold with the arms closed was connected to a 'Speedivac' pump with a phosphorus pentoxide trap. By means of a small leak in the manifold, the pressure was adjusted to *c.* 10 mm. mercury.

The suspensions used for the inoculation of the plugs were prepared by diluting nutrient broth cultures of the organisms 1 : 250 with 5 per cent glucose. Cultures at or near the end of the logarithmic phase were used. By means of a capillary pipette tipped with paraffin wax to which a syringe was attached, a single drop (*c.* 0·02 ml.) of the suspension was discharged on to the surface of each plug. As soon as each ampoule had been inoculated it was connected to a manifold arm which was then opened. Usually, 12–18 ampoules were inoculated at a time. Approximately 5 min. after the last ampoule had been connected, the leak was closed and high vacuum (*c.* 0·01 mm.) was established. The ampoules were taken off one at a time, constricted, replaced on the manifold and finally sealed off *in vacuo* after 1 hr. The ampoules were stored at room temperature in the dark.

The immediate effect of the inoculation of the freeze-dried plug is a localized viscous solution of the solids. Wetting of the entire plug is prevented by subsequent rapid removal of water by the pump. The exposure of the plugs to the higher pressure (10 mm.) induces a mild foam which may rise 1–2 mm. above the surfaces of the plugs; at the lower pressure (0·01 mm.) dehydration of this viscous foam proceeds very rapidly.

Some preliminary experiments have shown that the method may be simplified where percentage estimates of survival are not required. Smaller plugs (0·25 ml.) in tubes of ¼ in. diameter have been 'stab' inoculated by means of a straight wire charged with bacterial suspension. With such modifications no visible foaming of the peptone has occurred under reduced pressure, and drying *in vacuo* has been achieved by exposure of the plugs to high vacuum as soon as they have been inoculated.

At present a number of factors are being investigated in relation to the method. Meanwhile, it is of interest that the survival-levels shown in these early experiments compare favourably with those obtained by previous drying methods.

I am indebted to the Medical Research Council for a personal research grant.

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[1] Fry, R. M., and Greaves R. I. N., *J. Hyg. Camb.*, **49**, 220 (1951).

Egg-laying in Ctenophora

While occupied with field-work on Siphonophora, I placed six small *Pleurobrachia* sp. measuring about 2·5 mm. in length in a watch-glass at 1100 hr. on April 29. An hour later I noticed that eggs were being extruded through the ectoderm over the gastrovascular canals. Since the fertilization membrane was present as the eggs were being extruded, it would appear that fertilization took place inside the meridional canals. By 1430 hr. the first and second cleavages of the majority of the eggs were taking place as in *Beroe*. By 1830 hr. the numerous micromeres were covering the macromeres by epiboly and many of the larvæ had reached the stage of gastrulation. Within twenty-four hours of extrusion the larval ctene-plates could be seen beating within the egg envelope. The same phenomenon was witnessed with another batch of *Pleurobrachia* on May 7, when less than half the eggs segmented.

A recent text-book states that ripe sex cells in Ctenophora are discharged through the mouth except in *Coeloplana* and *Ctenoplana*, in which the testes open on the aboral surface by ducts.

I am informed by Miss M. A. Harvey, who confirmed my observations of April 29, that she has observed eggs being extruded through the ectoderm in a similar way in *Beroe ovata* and *Lampea pancerina*; but in the former, development of the eggs did not take place, while the eggs of the latter were not kept.

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Permeability to Water of the Lamprey Integument

The relationship between the anadromous lamprey, *L. fluveatilis*, and the purely fresh-water form, *L. planeri*, has been the subject of much discussion, and doubt has sometimes been expressed as to whether they should be regarded as distinct species. As Weissenberg[1] showed, although there are profound differences in the biology of the two forms, there are no important morphological criteria (other than size) by which they may be differentiated. It is therefore of especial interest to find that significant physiological differences exist between these species in regard to the permeability to water of the integument.

The rate of osmotic uptake in fresh water has been determined by weighing at intervals animals in which the urino-genital papilla has been ligated. In the sexually mature animal, the possibility of water absorption in the gut can be excluded, since the fore-gut is no longer patent. Expressed as percentage increases of weight, the mean rate for *fluveatilis* was found to be 1·1 per cent per hr. in tap water at 13·5° C., compared with 5·1 per cent per hr. for *planeri* in tap water at 12° C. As measured by the thermoelectric method, the osmolar concentration of the blood of *fluveatilis* at the time of the experiments varied from 135 to 150 m*M* with a mean value for six animals of 143 m*M*; the corresponding mean value for a large number of determinations on *planeri* was 110 m*M*. The osmotic gradient in tap water is therefore rather greater for *fluveatilis*, and hence the difference in permeability between the two forms would appear to be even greater than is indicated by the rates of uptake of water.

The rate of flow of urine implied in these figures is, for *planeri* at least, far in excess of that recorded for any other aquatic vertebrate in fresh water, and even the reduced rate in *fluveatilis* is about twice that of the eel[2], the skin of which bears a resemblance to that of the lamprey.

These results are in general agreement with those obtained for the rate of loss by osmosis in hypertonic solutions. In Fig. 1, the mean percentage hourly

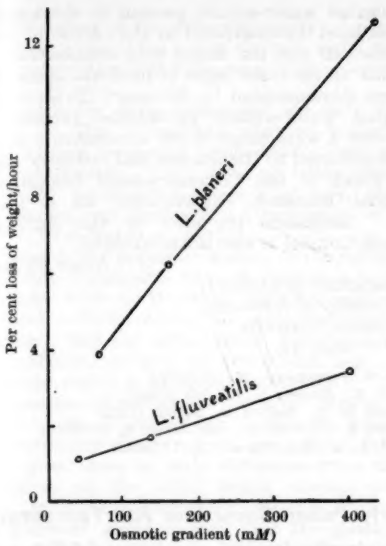

Fig. 1. Osmotic loss of water in sea water and sea water dilutions

losses of weight have been plotted against the approximate osmotic gradients in the various concentrations of sea water used. Interpolating from these curves, the osmotic losses for concentration gradients similar to those experienced in tap water (but in the reverse direction) are for *planeri* 4·6 per cent/hr. and for *fluveatilis* 1·7 per cent/hr.

Such differences between the two species are sufficient in themselves to explain the much greater tolerance shown by *fluveatilis* to direct transfer from fresh water to sea water. Whereas *planeri* survives only for a few hours in sea water diluted with two volumes of tap water and succumbs in an hour or so in pure sea water, *fluveatilis* will often survive indefinitely in equal parts of tap water and sea water and may live for several hours in pure sea water. But, although the lower water permeability of *fluveatilis* offers some immediate relief from the difficulties encountered in moving from fresh to salt water, it may well be that this characteristic would be of greater significance for an animal returning to fresh water from the sea. It seems reasonable to suppose that for *planeri* in fresh water the kidney is working close to the upper limits of its capacity, and that substantial increases in the concentration gradient could not be tolerated. It is perhaps for this reason that ammocœtes and adults in which the internal concentration has been raised by a period in hypertonic saline solutions sometimes die when returned to tap water. There are reasons for believing that the osmolar concentration of the blood of *fluveatilis* when it first leaves the sea on its spawning migration would be considerably higher than in the animals employed in these experiments, and a lower level of permeability to water may therefore be essential to their survival during this phase of the life-history.

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[1] Weissenberg, R., *Zool. Anz.*, **63** (1925).
[2] Smith, H., *J. Biol. Chem.*, **81**, 727 (1929).

The Wet-film Indian Ink Method for examining Micro-organisms

Recent experience with the wet-film indian ink method, used by Duguid[1] for demonstrating bacterial capsules and slime, suggests that it can be used for examining the structure of a wide range of living micro-organisms. To be effective for this purpose, an ink should have very small, uniformly sized particles, should spread evenly and should not coagulate too readily. These requirements are met by 'Pelican' black drawing ink, though it does coagulate to some extent in acidic suspensions. Several other inks proved unsatisfactory, chiefly because of larger and more variable particle-size.

With small unicellular organisms it is generally best to mount in undiluted ink. A drop (about 0·01 ml.) is placed on a clean slide, and the organism, preferably from a young growth on a solid medium, is gently mixed into it with a loop. Where it proves difficult for any reason to obtain a satisfactory density or distribution of organisms, a suspension may be prepared in a small loopful of water prior to mixing with the ink. A No. 1 coverslip is placed on the suspension which is then further spread out by pressing slide and coverslip firmly between blotting paper. The optimum thickness of film varies with the size of organism and may be determined by trial; in general, portions of film medium to dark brown in colour are satisfactory for examination with 1/12 oil-immersion objectives.

Such preparations may be used for demonstrating not only bacterial capsules, as Duguid showed, but also bacterial spores. Stages in spore formation may be seen, for example, with *Bacillus megatherium* grown on potato agar at 27° C. for 18–24 hr. With this species it is possible to see other details of internal cell structure. The structure of yeast cells can be seen by mounting in indian ink, and rewarding preparations can be made of a species such as *Schizosaccharomyces octosporus*, grown on malt agar at 25° C. for seven days, to demonstrate stages of ascospore formation. One important advantage of this wet-film method is that artefacts are largely avoided; further, there is little evidence that the ink is toxic to organisms, since in dilute suspensions motile bacteria remain active for some time.

Preparations provide good subjects for photography: motion of cells induced by intense Brownian movement of the ink particles, which might interfere, can be limited by adjusting the thickness of the film so that cells are just held between slide and coverslip. Mounts can often be preserved for 24 hr. or more in a moist chamber at 5° C.

With fungi, it is usually desirable first to obtain mycelial growth over a glass coverslip or square of 'Cellophane' lying on an agar medium. Mycelium is best mounted in ink diluted 1 : 5 to 1 : 10 with water, one convenient method being to make an ordinary water mount and then to introduce a loopful of ink which can be dispersed with a minimum of disturbance to the material. Coverslips with mycelial growth may be mounted directly, only slight pressure being applied to slide and coverslip to spread the diluted ink suspension. Mycelial growth on 'Cellophane' can sometimes be transferred directly to a slide (by placing it face downwards, pressing gently, and then stripping the 'Cellophane' off); but where this is not possible, a small piece of 'Cellophane' is cut from the square and placed face upwards on the slide. In either instance the mount is made with

diluted ink. By this means preparations can be made of a variety of fungal material, including that obtained directly from infected plants, results being particularly valuable when such material is delicate and subject to distortion by fixing, as, for example, with asci of *Eremascus*.

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[1] Duguid, J. P., *J. Path. and Bact.*, **63**, 673 (1951).

The Cuticle of Nematode Larvæ

The infective larval stage of many nematode parasites is ensheathed in the uncast cuticle of the second stage. The sheath is regarded as having some protective function in a larval stage which is more resistant to environmental fluctuations than the earlier stages. A method has been devised for separating the sheaths from larvæ, and it has been found that their protein complement is water-soluble. In this communication, the amino-acid composition of these proteins is discussed.

Mixtures of third-stage larvæ of *Oesophagostomum*, *Ostertagia*, *Chabertia*, *Haemonchus* and *Trichostrongylus* from sheep were examined. Pure samples of *Haemonchus contortus* larvæ were also used.

Exsheathment was obtained *in vitro* using solutions of sodium hypochlorite, as described by Lapage[1]. As soon as exsheathment occurred the larvæ were centrifuged, the supernatant removed and the cuticles separated from the active larvæ by differential centrifugation in saturated sodium chloride. The cuticles were then washed five or six times in distilled water and placed in sealed tubes at 105° C. for 12 hr. This caused the solution of the cuticles in distilled water, leaving a slight residue which microscopically was seen to be plant debris and which gave a negligible ninhydrin reaction after acid hydrolysis.

The cuticles in solution were hydrolysed in sealed tubes at 105° C. in 6*N* hydrochloric acid for 24 hr. The hydrolysate was examined by two-dimensional paper chromatography using 80 per cent ethanol and water-saturated phenol as solvents.

By comparison with a prepared map of known amino-acids, the presence of nine amino-acids was demonstrated in the hydrolysates of both mixed collections and pure samples of *Haemonchus contortus*. These amino-acids in approximate order of the amounts present were proline, hydroxyproline, aspartic acid, cysteic acid, glutamic acid, alanine, leucine, glycine and valine. This order was obtained on considering the size of the spot and the sensitivity of the different amino-acids to ninhydrin as estimated by Dent[2]. The first four were recognized by their position, colour and conformation. The presence of leucine and valine was verified using a marker procedure. Proline was detected by its colour in ninhydrin and isatin; hydroxyproline by its similar colour in ninhydrin and isatin and its specific red colour on the application of Ehrlich's reagent after isatin. Glycine was recognized by its colour, and though its position on the map could have been shared with arginine and serine, these two amino-acids were proved to be absent by other tests. Tests for cystine and tyrosine also gave negative results.

The presence and composition of water-soluble exoskeletal protein in the Invertebrata has been firmly established in the Insecta by several workers, most recently by Hackman[3]. The presence of somewhat similar water-soluble protein in the nematoda has also been demonstrated in the cuticle of *Ascaris* by Chitwood[4] and the amino-acid composition of an 'albumen' in the outer layer of fertilized *Ascaris* eggs has been demonstrated by Kreuzer[5]. It seems probable that water-soluble exoskeletal proteins may occur over a wide range of the invertebrate animals.

I am indebted to the Science and Industry Endowment Fund of the Commonwealth Scientific and Industrial Research Organization for a personal grant. Assistance provided by the Agricultural Research Council is also acknowledged.

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[1] Lapage, G., *Parasitology*, **27**, 186 (1935).
[2] Dent, C. E., *Biochem. J.*, **43**, 169 (1948).
[3] Hackman, R. H., *Biochem. J.*, **54**, 362 (1953).
[4] Chitwood, B. G., *Proc. Hel. Soc. Wash.*, **3**, 39 (1936).
[5] Kreuzer, L., *Z. vergl. Physiol.*, **35**, 13 (1953).

Newly Fallen Snow and Air Temperature

The physical features of a layer of fallen snow at a given time are chiefly dependent on (1) meteorological conditions while the snow is falling, and (2) meteorological factors which occur later causing metamorphosis of the snow.

Some observations I have made in the Italian Western Alps have shown that the apparent density of newly fallen snow is variable and depends on air temperature during the fall. On account of the lack of systematic high-altitude observations in Italy showing low negative temperatures (centigrade), I have worked on the accurate data gathered at the Weissfluhjoch (2,540–2,660 m.), near Davos (Switzerland), already published[1]. Excluding the cases of new snow less than 10 cm. deep and snowfalls occurring with strong wind (causing *Schneetreiben*), as well as those with air temperature reaching or near 0° C., it was found that the apparent density of the newly fallen snow depends upon the mean air temperature during the fall (see Fig. 1). The mean values of the air temperature are somewhat approximate, as deduced from the maximum and minimum temperatures, as well as from observations at 7 hr. 30 min., 13 hr. 30 min. and 21 hr. 30 min., during the time of snowfall; however, they are referred to the

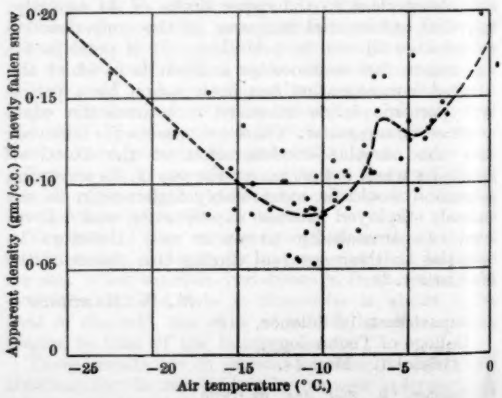

Fig. 1

separate values of the apparent density, because this was obtained from the top of the new snow and from the corresponding water content, both observed only at 7 hr. 30 min.

Although the cases considered are only 53 (+ 2 near 0° C.), Fig. 1 indicates that at Weissfluhjoch the maximum frequency of snowfall occurs with air temperature near − 11° C. For air temperatures less than − 17° C. snowfall seems very rare, and only one case was recorded with a temperature at nearly − 25° C. (on March 4, 1949).

As regards the apparent density of the newly fallen snow, Fig. 1 indicates that it reaches a minimum value near − 11° C. However, the behaviour between − 5° and − 7° C., where the scattering is great, is uncertain; but the extrapolated curve appears the most probable. It is to be noted that near − 4° C. the points reveal a minimal dispersion.

The results obtained are believed not to be restricted to the Weissfluhjoch, where the position of the observatory nearly at the top of the mountain assures that there is little difference from the free atmosphere at the same height during snowfall. Indeed, from laboratory investigations, W. Rau and other authors[2] demonstrated that the greatest frequency in the spectrum of the ice-forming-nuclei occurs between − 10° and − 12° C., while a secondary maximum lies near − 4° C. As the ice nucleation in the atmosphere is the same as in the laboratory[3], it is obvious that the greatest frequency of snow should occur near − 11° C. when the appropriate meteorological condition for precipitation exists in the atmosphere. (*Note added in proof.* Using the meteorological observations made in different observatories at the top of high mountains (cf. Bossolasco, *Geofisica pura e appl.*; in the press) the above results have been proved to be general.)

With reference to the corresponding minimum apparent density of the newly fallen snow, E. Wall and U. Nakaya have already pointed out that the form of ice-crystals also changes with temperature. Near − 11° C. the stellar form prevails, and this explains the minimum density of the snow at this air temperature.

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April 20.

[1] "Schnee und Lawinen in den Winter 1942/43 bis 1945/46; 1948/49 bis 1950/51" (Eigg. Institut f. Schnee- und Lawinen-forschung, Weissfluhjoch/Davos).
[2] Mason and Ludlam, "Reports on Progress in Physics", **14**, 147 (1951).
[3] Rau, *Geofisica pura e appl.*, **26**, 75 (1953).

Solar Tides in the Lower Stratosphere

While methods of representing the 100-mb. wind field were under investigation, diurnal and semi-diurnal variations were detected in winds observed at the 100-mb. level from British upper air stations. These periodic variations of wind appear to be associated with the atmospheric solar tides. 100-mb. wind observations are particularly suitable for study in connexion with tidal oscillations, since, at least between latitudes 30° N. and 60° N., the synoptic variations of wind are considerably smaller at that level than in the upper troposphere. The lower stratosphere is also free from the smaller-scale effects which may mask tidal wind variations occurring in the lower troposphere.

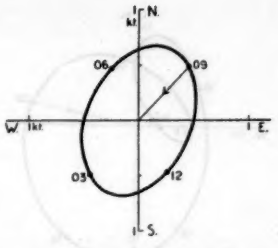

Fig. 1. Vector diagram giving the wind velocity due to the semi-diurnal oscillation. The wind velocity at any time is defined by the line joining the appropriate point on the ellipse to the origin

The deviations of the annual mean south and west 100-mb. wind components at 0300 G.M.T., 0900 G.M.T., 1500 G.M.T. and 2100 G.M.T. from the respective overall annual mean wind components were computed from two years wind observations made using *G.L.*III radar equipment. Similar deviations for 0600 G.M.T., 1200 G.M.T., 1800 G.M.T. and 2400 G.M.T. were obtained from unpublished 150-mb. observations supplied to me by H. W. L. Absalom. The latter refer to four years of wind observations made, for the most part, by radio direction-finding techniques. Harmonic analysis yielded the following expressions for the annual mean oscillation of each component:

$$100\,S = -54\cos(\theta + 32°\,14') + 67\cos(2\theta + 44°\,24');$$
$$100\,W = 51\cos(\theta + 84°\,24') + 51\cos(2\theta - 29°\,3');$$

where S and W are the south-wind and west-wind components in knots and θ ranges from 0 to 360° as time varies through 24 hr. from 0300 G.M.T. The third and fourth harmonics were not statistically significant.

The semi-diurnal oscillation is illustrated by Fig. 1, which is a vector diagram giving, for any time, the wind velocity due to the oscillation. The stratospheric oscillation is approximately in phase with the surface wind oscillation derived theoretically by Bartels[1] from Simpson's expression[2] for the semi-diurnal variation of surface pressure. Such a relationship is to be expected from tidal theory[3]. The amplitudes of the lower stratospheric wind component oscillations, 0·67 knot and 0·51 knot for the south- and west-wind components respectively, are of comparable magnitude to the amplitude of Bartels's derived surface-wind component oscillations in latitude 55° N., namely, 0·87 knot for the south component and 0·85 knot for the west component.

The diurnal oscillation is given by Fig. 2. The amplitudes of the diurnal and semi-diurnal oscillations are similar in the lower stratosphere. Fig. 3 gives the resultant wind velocity due to the combined diurnal and semi-diurnal oscillations.

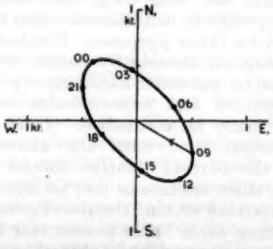

Fig. 2. Vector diagram giving the wind velocity due to the diurnal oscillation. The wind velocity at any time is defined by the line joining the appropriate point on the ellipse to the origin

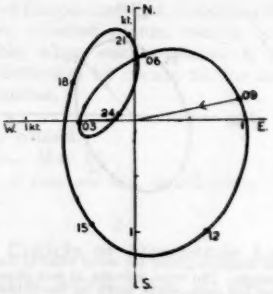

Fig. 3. Vector diagram giving the resultant wind velocity due to the combined diurnal and semi-diurnal oscillations. The wind velocity at any time is defined by the line joining the appropriate point on the curve to the origin

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April 27.

[1] Bartels, J., "Handbuch der Experimentalphysik", **25**, 163 (1928).
[2] Simpson, G. C., *Quart. J. Roy. Met. Soc.*, **44**, 20 (1918).
[3] Wilkes, M. V., "Oscillations of the Earth's Atmosphere" (Camb. Univ. Press, 1949).

Electron Irradiation of Polythene

Considerable attention has recently been given to the effects of high-energy radiation on polymeric substances[1]. The effects would appear to be of the same fundamental character whether X-rays, electron bombardment, or the mixed radiations of the atomic pile are used; it is reported that in the absence of oxygen the dominant reactions are either cross-linking or chain-scission, and polymers have been classified according to their behaviour in these respects when irradiated. Some of the most interesting effects have been observed in polythene, where cross-linking causes major changes in physical and mechanical properties, particularly at temperatures above the crystalline melting point.

Experimental work to date has of necessity been performed with whatever source of radiation was available, and this has sometimes imposed severe restrictions on the scope of the investigations. When X-rays are used little energy dissipation occurs in the material and very long exposures are required, while use of the atomic pile imposes a fixed and high ambient temperature, exposures are still long, and often specimens can only be withdrawn when the pile is opened for other purposes. Bombardment of a specimen directly by means of an electron beam, on the other hand, gives good energy dissipation and experimental conditions may easily be controlled. It is required, however, that both the electron energy and the current density should be high, so that thick specimens can be treated with short exposure times. The development of the travelling-wave linear accelerator has provided an equipment which fulfils these requirements. Machines of this type operating at 8 MeV.[2] and at 4 MeV.[3] are being used as X-ray generators for clinical purposes, and one of the latter units has been adapted for the electron irradiation of specimens by extracting the electron beam through a thin copper window.

At the nominal maximum rating of the machine, 500 W., a mean current of 125 μamp. is obtainable, and for experimental purposes the window scatters the beam so as to give almost uniform coverage over an area 20 cm. in diameter at a distance of 70 cm. from the window. Further, it is found that the effect of irradiation throughout the specimen may be fairly uniform, varying only by about ± 10 per cent over a substantial part of the electron range (about 2 cm. in polythene for 4-MeV. electrons).

A detailed investigation of the behaviour of polythene when bombarded by 4-MeV. electrons is now in progress, and some of the preliminary results are indicated below.

It is well known that a sufficient degree, α, of random cross-linking produces from an initially soluble polymer a gel fraction the magnitude of which, x, is determined by the original molecular weight distribution, $W(n)$. For polymers cross-linked by radiation, the relationship between these three parameters is often complicated by chain-scission. If, as is probable, this is a random process occurring to an extent proportionate to α, then x has been shown to approach a limiting value, x_L; this limiting value is determined by the ratio, β, of main chain-scissions to atoms cross-linked[4]. In practice, however, x_L can only be measured at reasonable degrees of cross-linking on the often uncertain assumption that the initial polymer contains little low-molecular weight material.

The development of a soluble fraction can, on the other hand, be clearly observed when the extracted gel fraction of a lightly cross-linked polythene is further irradiated (see Fig. 1).

This experiment gives a positive demonstration of the occurrence of chain-scission; and the results suggest that the limiting soluble fraction lies between 2·4 and 2·8 per cent. This value is appreciably less than that previously suggested for polythene irradiated in an atomic pile on the basis of an assumed simple exponential distribution of molecular weights[5]. Corresponding to the range of values observed for the limiting soluble fraction, the value of β lies between

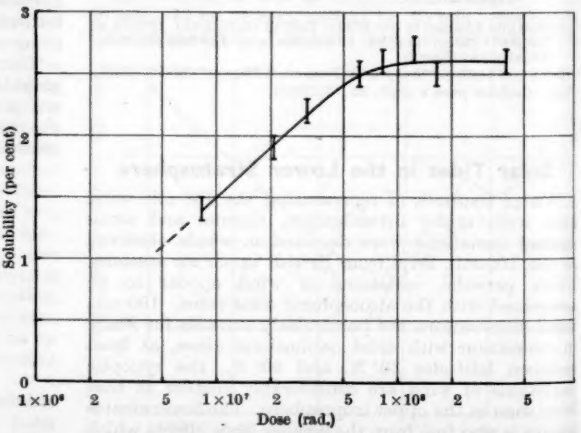

Fig. 1. Soluble material formed by the irradiation of a polythene gel fraction
Note. Soluble fraction of original gel is 0·4 per cent; dose is expressed in rads. (see *Nucleonics*, **12**, No. 1, 11). 1 rad. ≡ 100 ergs./gm.

0·18 and 0·20. With this knowledge, it is possible to estimate with reasonable accuracy the gel fractions which would be obtained if no chain-scission occurred. One of us (A. C. B.) has applied this information to the calculation of the original molecular-weight distribution-functions of a series of polythenes, with the necessary exception of the low-molecular weight tails. The results obtained suggest that polythenes have wide molecular-weight distributions, such as have been indicated by a comparison of number-average molecular weights with weight-average molecular weights determined by light scattering[6]. This work will be reported more fully elsewhere.

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[1] Charlesby, A. *Nature*, **171**, 167 (1953). Sisman, O., and Bopp, C. D., *ORNL* 928 (Oak Ridge National Report). Little K., *Nature*, **170**, 1075 (1952). Lawton, E. J., Bueche, A. M., and Balwitt, J. S., *Nature*, **172**, 72 (1953).
[2] Miller, C. W., *Nature*, **171**, 297 (1953). *Proc. Inst. Elect. Eng.*, Pt. 1, **101**, 207 (1954).
[3] Miller, C. W., and Howard-Flanders, P., *M-V. Gaz.*, **25**. 412 119 (1953).
[4] Charlesby, A., *J. Poly. Sci.*, **11**, 513, No. 6 (1953).
[5] Charlesby, A., *Proc. Roy. Soc.*, A, **222**, 60 (1954).
[6] Billmeyer F. W., *J. Amer. Chem. Soc.*, **75**, 6118 (1953).

Surface Films of Poly-di-methyl Siloxanes on Organic Liquid Substrates

In contrast with organic compounds, there is evidence that small quantities of silicones are capable of exerting marked surface activity when incorporated in organic liquids. Often this activity is manifest even when the silicone is immiscible with the organic liquid. Such effects could imply that the activity arises, not through adsorption at the air/solution interface, but rather through the existence of insoluble films analogous to those established for aqueous substrates.

This communication records some preliminary evidence for the existence of such films of a poly-di-methyl siloxane of viscosity 20 centistokes. This material of average molecular weight about 2,000, corresponding to a chain of twenty-five di-methyl-siloxane units, was applied as a solution in ether, in small quantities, to the surface of a number of liquid substrates, and the surface tension lowering was determined by the Wilhelmy method, the force being measured by means of a torsion wire and a suitable optical system.

Initially, a large lowering of tension resulted after addition of the silicone to the surface, which decreases usually in about ten minutes to a steady value; in isolated cases this value remained steady within 0·25 dyne overnight. As a proof of the existence of these films the surface pressure could be raised or lowered by varying the area of the film with a specially constructed barrier consisting of a strip of brass thick enough to extend below and above the interface by a few millimetres and sealed to the brass sides of a rectangular trough by mercury–brass amalgam. Changes in area resulted in hysteresis in the pressure such that, for example, compression gave immediately a high pressure which decayed to a lower value, while on returning to the original compression the final pressure was lower by less than 1 dyne from that at the beginning of the cycle. Variation in compression of the film-free side of the barrier gave no evidence of changes in pressure. In spite of this barrier method, and because of the ever-present danger of leakage across the mercury barrier, most of the measurements were made on a constant area by varying the amount of silicone added.

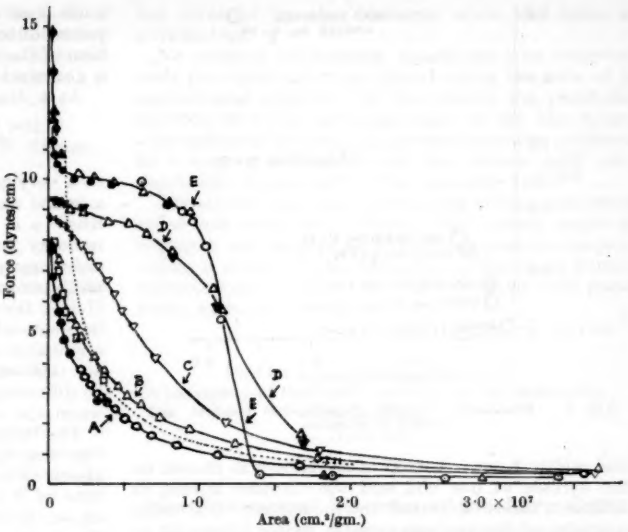

Fig. 1. Force–area curves for poly-di-methyl siloxane (*D.C.*20) at the interface of air and various substrates: (*A*) oleic acid; (*B*) olive oil; (*C*) tri-acetin; (*D*) ethylene glycol; (*E*) distilled water. The dotted curve is calculated for a gaseous film of molecular weight 2,000

Fig. 1 shows some typical force-area diagrams for a number of substrates. It is clear that the substrate has a marked influence in varying the compressional behaviour of the film, varying from that suggestive of a gaseous state to that suggesting phase transitions. Examination of the films by dark-field illumination at the highest compressions and even with a spread drop of the undiluted siloxane failed to reveal any so-called 'point structure' or patches of unspread material.

Some observations were also made on the spreading of drops of the undiluted siloxane. On all the substrates examined, the drop lost its identity immediately and the spreading film at intermediate thicknesses gave readily observable interference fringes of remarkable regularity, which finally disappeared with continued spreading. Lycopodium powder was found to be the most generally useful means of detecting the presence and location of films, and was used for measuring the rate of advance of a spreading film. The substrate was contained at a depth of about 0·5 cm. in a rectangular trough of length 95 cm.

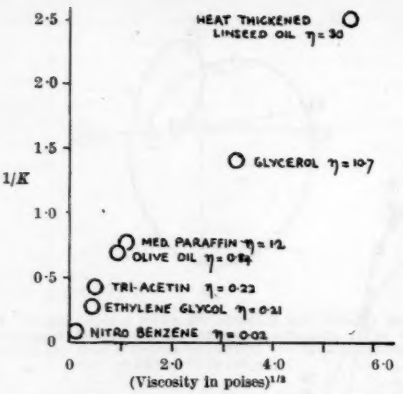

Fig. 2. Relationship between spreading-rate constant and viscosity of substrate

and width 2 cm. A drop of siloxane was placed on the surface at one end and the distance spread at different times indicated by movement of a small quantity of lycopodium powder gently blown on to the surface. It was found that for all the liquids examined the distance l travelled in a time t was accurately represented (for distances of at least 50 cm.) by $l = kt^{1/2}$, and of particular interest is the dependence of the rate constant k on the viscosity of the substrate.

General considerations suggest that k might be expected to show an inverse dependence on the square root of the viscosity of the substrate; that this is approximately so is demonstrated in Fig. 2. This relationship is remarkable when one considers the variation in chemical nature of the substrates and that their viscosities vary by some 1,500-fold.

The bearing of these results on the mechanism of spreading will be elaborated in a fuller publication of this work.

I wish to acknowledge some preliminary measurements made by Mr. J. Beasley, and also the assistance of Mr. R. Golledge in some of the spreading measurements. This communication is published by permission of the Director and Council of the Printing, Packaging and Allied Trades Research Association.

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Angle of Contact of Mercury against a Moving Tungsten Wire

During preparations for the measurement of the density of mercury by weighing in it a cube of tungsten carbide of known volume, it was necessary to measure the surface tension force exerted by the mercury on the 0·002-in. diameter tungsten wire used to suspend the cube. The method developed for measuring the angle of contact and the behaviour of the angle of contact against an oscillating wire may be of more general interest.

The mercury surface around the point of entry of the wire was photographed through an optical system such that no light entered the camera from those points of the surface at which θ, the angle of inclination of the surface to the horizontal, exceeded a value ψ governed by the geometry of the optical system.

At a distance x from the axis of the wire,

$$\sin\theta = \sin\theta_c \cdot K_1(bx)/K_1(ba),$$

to a very good approximation. θ_c is $(\alpha - \pi/2)$, where α is the angle of contact at the wire; $b = (g\rho/\gamma)^{1/2}$, where ρ is the density and γ the surface tension of mercury; and $K_1(bx)$ is the modified Bessel function of order unity. When $\theta = \psi$, x is the radius of the unilluminated part of the image of the mercury surface. Hence, from x measured on the photograph, θ_c can be deduced. This method of finding θ_c should be applicable to other liquids and other forms of boundary (although the equation to the surface would then be different). The method should be especially useful when the surface is inaccessible.

The balance from which the tungsten carbide cube was suspended was set oscillating (the period being about 32 sec.) and photographs were taken at intervals of 2 sec. The variation of angle of contact, shown in Fig. 1, was periodic but not sinusoidal. The form of the curve appears to indicate that there is a non-linear frictional contact force. A frictional contact force has been postulated by Yarnold[1] (following Adam and Jessop[2]) to explain his results on the hysteresis of the angles of contact of the surfaces of mercury indexes moving in glass tubes and of the surface of mercury against steel balls. Our results differ from his in that, among other respects, they show angles of contact of less than 90°. Our value for the static angle of contact, about 135°, agrees with his.

The surface of the mercury in our experiments was cleaned by sucking off the dust and upper liquid. Our results were quite reproducible, but neither the wire nor the mercury were specially cleaned apart from forming a fresh surface on the mercury for each run of photographs, since the observations were not undertaken to investigate surface phenomena.

We are indebted to Mr. J. W. C. Gates of the Light Division of the National Physical Laboratory for advice and to Mr. G. F. Miller of the Mathematics

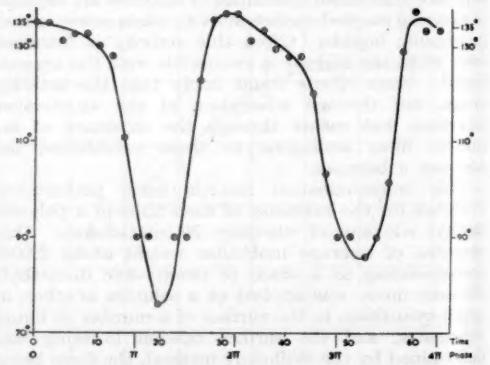

Fig. 1. Variation of angle of contact of mercury against a tungsten wire moving vertically with damped simple harmonic motion of period 32 sec.

Abscissæ: Above, time in seconds measured from instant when wire is passing downwards through mid-point with maximum velocity; below, phase measured from same instant.
Ordinate: Angle of contact, degrees.

Division for obtaining the expression for the form of the mercury surface. The experiments described above are part of the research programme of the National Physical Laboratory and this communication is published by permission of the Director.

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N. W. B. Stone

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May 19.

[1] Yarnold, G. D., *Proc. Phys. Soc.*, **50**, 540 (1938); **58**, 120 (1946).
[2] Adam, N. K., and Jessop, G., *Trans. Chem. Soc.*, **127** (Pt. 2), 1863 (1925).

Use of a Gaseous Discharge as an Identifiable Radar Target

The use of gaseous discharges as generators of radio noise has been widely reported in the literature, and work in this field is in progress at this Laboratory. Due to the high conductivity of gaseous discharges at microwave frequencies, a major problem in the design of a 'noise source' is a suitable means of introducing the discharge plasma into the electromagnetic field of the radio transmission circuit to provide a reflexionless match. It is readily demonstrated that a sudden introduction of a gaseous discharge into the path of an electromagnetic wave will produce a large reflexion of the incident power, and this fact has been used to produce a variable reflector of radio-frequency energy, thus providing in effect a modulated radar target.

It can be shown that a standard fluorescent light tube operating from the 50 c./s. mains supply will reflect 3-cm. radio waves, the reflected signal having a 100-c./s. modulation. By placing such a tube at the focus of a parabolic cylinder, the total reflected signal is considerably increased due to the larger amount of energy being intercepted by the parabola, and depending on the condition of the discharge tube for its reflexion.

The mechanism of the process is interpreted simply as follows. Energy intercepted by the parabola is focused on to the discharge tube. If the plasma is present, then because it has a high conductivity it reflects most of the incident power, and a large signal is returned. If, however, the discharge is extinguished the reflexion of power is from the glass of the tube and is of much less magnitude. At intermediate levels the reflexion depends on the current in the discharge. It has been found that excellent square-wave modulated returned signals are obtained if the discharge tube is suitably driven, that is, if a square wave-form of current is produced through it.

It has been found equally effective to arrange a similar discharge tube along the axis of a paraboloid. In this case the position of the tube is not critical over most of its length, although when the end of the tube is near the focus the additional effect of the electrode acting as a reflector behind the portion of plasma at the focus appears to give an improved total reflexion.

Further experiments have also been carried out with a 'beehive' neon lamp. In this case, the effective portion of the discharge is the cathode glow, and it is thought that the mechanism in this case may be the opposite of the earlier example, with the metal structure in the lamp normally acting as the reflector but screened by the discharge when the lamp is switched on.

No marked polarization sensitivity was observed with the discharge tube placed along the axis of a paraboloidal reflector. In the case of the parabolic cylinder with the discharge tube on the line focus, a considerable increase in performance was obtained at 3 cm. wave-length, with the electric field perpendicular to the axis of the discharge tube.

The device is of use in adjusting continuous wave radar sets where some form of fluctuating target is required, and may possibly have applications in providing a means of identification for the usual corner reflector types of target used in association with pulse radar systems.

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April 15.

Non-isothermal Plasmas in the Rare Gases

Kenty[1] noticed, many years ago, the finite lapse of time occurring between the termination of current flow in a low-pressure discharge in argon and the occurrence of maximum visible intensity of the afterglow. He suggested that the latter was due largely to radiative electron-ion recombination, and that the time-lapse was necessary for the electron temperature to fall to a value comparable with the gas temperature when the afterglow intensity would have reached a maximum, since recombination would continually reduce the electron and ion density. Bayet[2] and others have noticed a similar phenomenon and attribute it to the same cause. Also, an analogous effect due to pickup, in the afterglow, of electron energy from a microwave beam has been elegantly demonstrated by Goldstein and his collaborators[3].

Bayet[2] suggests that effects due to metastable excited atoms may be ignored at sufficiently high pressures. Moreover, Biondi[4] has shown that increased afterglow ionization due to metastable atom collision processes would tend to increase with increasing pulse-length (up to a limiting pulse-length, set by the time required to establish a full metastable atom population); this is in contrast with our results (Fig. 1), which show a decreasing afterglow light peak at increasing pulse-lengths.

For some years we have observed these effects in the rare gases, and the purpose of the present communication is to present preliminary data which are consistent with the recombination mechanism and which enable a recombination coefficient to be estimated. In view of the current interest in recombination processes, summarized by Massey[5], any method capable of yielding results of potential value may be worth investigation.

We have worked mainly at 1 atmosphere pressure in cylinder neon and helium, with rectangular current-pulses of a few microseconds duration, in contrast with the damped-condenser discharges used by Bayet[2], Olsen and Huxford[6] and others which render afterglow results more difficult to interpret. In high-pressure discharges, for example in helium, where the electron-atom energy transfer may be effected rapidly, the heating of the gas may be so great that there is a finite rate of electron production in the afterglow. This may be demonstrated by the non-

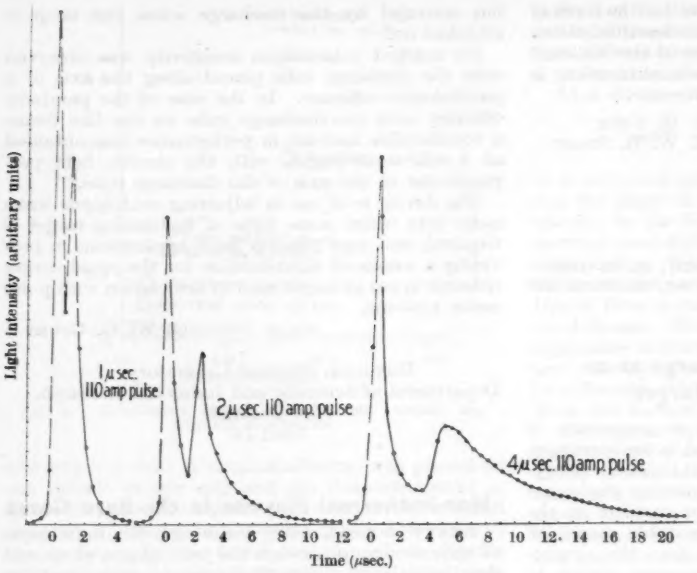
Light intensity (arbitrary units)
1 μsec. 110 amp pulse
2 μsec. 110 amp. pulse
4 μsec. 110 amp. pulse
0 2 4 0 2 4 6 8 10 12 0 2 4 6 8 10 12 14 16 18 20
Time (μsec.)

Fig. 1

linearity of the (light intensity)$^{-1/2}$ – time curve, which is necessarily linear for afterglows where radiative (two-body) recombination predominates, as Mohler[7] has shown. It is assumed, of course, that the recombination coefficient is constant throughout the time of observation. A recent discussion of the low-pressure work has been given by Massey and Burhop[8].

Our results show that the gas-heating effect is less, other things being equal, in neon than in helium, and that afterglows following pulses 1 microsec. long in neon show the requisite linear plot (Fig. 2*a*). Pulses of 4 microsec. (Fig. 2*b*) show non-linearity, also noticeable even in 0·8 microsec. discharges in helium. A recombination coefficient may be deduced if the electron density is known at any instant in the curve Fig. 2*a*. Measurements of the Stark effect have been made in this laboratory in helium and hydrogen; but for neon drift-current densities (averaged over the whole discharge channel, as a first approximation) give the electron density at 1 microsec. as $\sim 10^{16}$/c.c., and the resulting afterglow recombination coefficient as $\sim 10^{-10}$ cm.^{3}/sec. This value is appreciably less than the (dissociative) recombination coefficients ($\sim 10^{-8}$ cm.^{3}/sec.) obtained in ultra high-frequency studies[8], and may be attributable to dielectronic[5,8] or to electron-ion recombination.

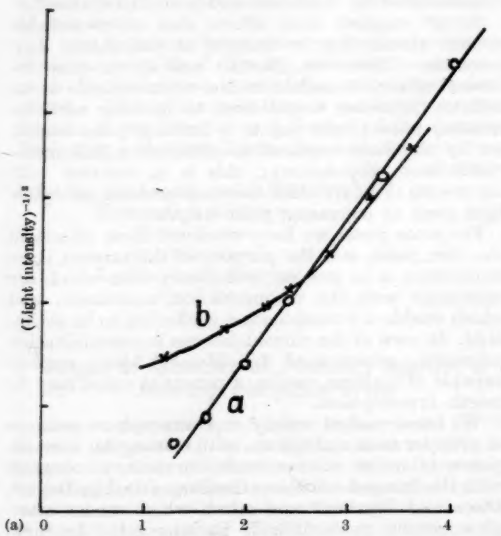

Fig. 2

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April 29.

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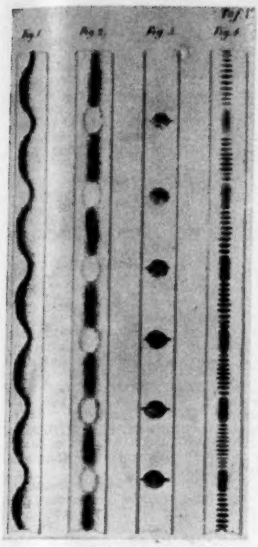
[1] Kenty, C., *Phys. Rev.*, **32**, 624 (1928).
[2] Bayet, M., *Rev. Sci. (Paris)*, **89**, 351 (1951).
[3] Goldstein, L., Anderson, J. M., and Clark, G. L., *Phys. Rev.*, **90** 486 (1953).
[4] Biondi, M. A., *Phys. Rev.*, **82**, 453 (1951).
[5] Massey, H. S. W., "Advances in Physics", **1**, 395 (1952).
[6] Olsen, H. L., and Huxford, W. S., *Phys. Rev.*, **87**, 922 (1952).
[7] Mohler, F. L., *Bur. of Stand. J. of Res.*, **19**, 447 (1937).
[8] Massey, H. S. W., and Burhop, E. H. S., "Electronic and Ionic Impact Phenomena" (Oxford, 1952).

Powder Ridges in a Sound Field

I have found that the distance between powder ridges, formed on a flat surface in a sound field[1], increases rapidly with the size of the particle. Those who describe Kundt powder ridges make no mention of this fact. My results, however, appear to be a 'rediscovery' of some of Kundt's[2] original observations which, in view of their importance, are reproduced in the accompanying illustration. Whereas his fine striæ were formed with lycopodium spores of diameter 20 μ, the wider *Rippen* shown on their right consisted of fine sand grains of peak diameter *c.* 200 μ.

Such results can be explained in terms of Andrade's[3] vortex theory (which has superseded Koenig's hydrodynamical theory) and may link up eventually with other studies in which there is relative oscillatory motion between viscous fluids and powders. Bagnold[4], for example, in his experiments on powder 'ripples, formed under oscillating water, found that the inter-ridge distances varied approximately as the square root of the diameter of the grains.

In my own observations, when there is more powder present, the ridges are wider and farther



the size of the particles.

MARY D. WALLER

5 Gloucester Gate,
London, N.W.1.
May 10.

[1] Waller, *Nature*, **166**, 961 (1950).
[2] Kundt, *Ann. Physik*, **127**, 497 (1866).
[3] Andrade *Proc. Roy. Soc.*, A, **134**, 445 (1931); *Phil. Trans.*, A, **230**, 417 (1932).
[4] Bagnold, *Proc. Roy. Soc.*, A, **187**, 1 (1946).
[5] Soellner and Bondy, *Trans. Farad. Soc.* **32**, 616 (1936).

Fluorescence of Naphthoquinones

ATTEMPTS to devise a method for the identification of vitamin K_1 and other naphthoquinones by filter-paper chromatography led to the chance observation that some of these compounds exhibit a characteristic fluorescence which can be used for their detection. 10 μgm. of vitamin K_1 was chromatographed in a 75 per cent (v/v) aqueous ethanol solution on Whatman No. 1 filter-paper impregnated with silicone. When the paper was dried and held before an ultra-violet lamp (3665 A.), an area of red fluorescence was seen at R_F 0·20. With prolonged exposure to the ultra-violet radiation (45–60 sec.), the red fluorescence changed irreversibly to an intense, green fluorescence which was stable for at least four months. When sprayed with alcoholic potassium hydroxide, the green fluorescence changed to an orange fluorescence.

Although necessary for proper separation of the substances, silicone-coated paper was not necessary for fluorescence. Spraying the chromatogram with alcoholic solutions of nickel chloride or ammonium iodide, substances that often quench fluorescence[1], had no effect.

Of nineteen alkyl, hydroxyl or chloro substituted 1,4-naphthoquinones observed on filter-paper, all fluoresced red. 1,4-Naphthoquinone itself had no obvious fluorescence, and neither 1,2-naphthoquinone nor its methyl derivatives fluoresced. None of the substances tested fluoresced in petroleum-ether or ethanol solutions, although some of the crystalline compounds in the solid state did. These observations suggest that substituted 1,4-naphthoquinones may react in the same way as those substances, tabulated by Pringsheim[1], some of which fluoresce only in the solid state, others in rigid media.

A detailed report of reversed-phase partition chromatography on filter paper of the naphthoquinones and their detection by fluorescence will be published elsewhere.

I thank Prof. Henrik Dam for his encouragement and support of this work.

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[1] Pringsheim, P., "Fluorescence and Phosphorescence" (Interscience, New York, 1949).

Liquid-State Equation for Normal Paraffins

BASED on measurements of liquid density and of heats of vaporization of the normal paraffin hydrocarbons, a very simple relationship has been deduced that appears to be of general applicability to this family of chemical compounds. The equation is as follows:

$$\frac{\rho - \rho_c}{\rho_0 - \rho_c} = \left[\frac{(1 + \alpha T)(-E/V)}{(-E/V)_0}\right]^{3/4},$$

where ρ is liquid density at the temperature of measurement[1]; ρ_c is critical density[2]; ρ_0 is liquid density extrapolated to absolute zero[3]; $(-E/V)$ is cohesive-energy density of the liquid at the temperature of measurement[4]; $(-E/V)_0$ is cohesive-energy density of the liquid extrapolated to absolute zero; and α is a constant (= 0·00125 for the *n*-paraffins).

The above relationship has been applied to the normal paraffins at atmospheric pressure over a range of temperatures from − 190° to + 345° C., and over a range of molecular weights from 44 to 283. The standard percentage error for the 73 points is:

$$100\left\{\frac{\Sigma[(y_{calc.} - y_{obs.})/y_{obs.}]^2}{n}\right\}^{1/2} = 0{\cdot}57 \text{ per cent},$$

where $y = \dfrac{\rho - \rho_c}{\rho_0 - \rho_c}$ and n is number of measurements.

Work is in progress to investigate a large number of non-polar liquids to determine whether or not they also conform to this simple equation. Compressibility data on the normal paraffin hydrocarbons are being taken for us by Arthur D. Little, Inc., of Cambridge, Mass., and a study by them of the compressibilities of other liquids is contemplated. At a later date this research will be extended to polar liquids in the hope that their behaviour also may be characterized by some modification of this relationship.

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South Charleston, West Virginia.
March 23.

[1] Dornte, R. W., and Smyth, C. P., *J. Amer. Chem. Soc.*, **52**, 3546 (1930). Doolittle, A. K., and Peterson, R. H., *J. Amer. Chem. Soc.*, **73**, 2145 (1951).
[2] Critical density values taken from smoothed curve representing results reported by Doss, M. P., "Physical Constants of the Principal Hydrocarbons" (Texas Co., New York, 1943).
[3] Doolittle, A. K., *J. App. Phys.*, **22**, 1471 (1953).
[4] API Res. Proj. 44, Carnegie Inst. Tech., "Selected Values of Properties of Hydrocarbons", Table 20m (April 30, 1949) Values at other temperatures interpolated or extrapolated by method described in Hildebrand, J. H., and Scott, R. L., "The Solubility of Nonelectrolytes", 434 (Reinhold, 1950).

FORTHCOMING EVENTS

Monday August 23—Saturday, August 28

Comité International de Photobiologie (at Amsterdam).—Fourth International Congress.

Wednesday, August 25—Wednesday September 1

Midlands Society for Analytical Chemistry (at the University, Birmingham).—Symposium on "Analytical Chemistry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Metallurgists or Physicists (2) (with a first- or second-class honours degree in metallurgy or physics, and several years postgraduate experience), one to work on casting and working of rare metals used in nuclear power reactors, and the other to work on the arc melting and welding of these metals—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/134 (August 27).

Assistant Experimental Officer (preferably with a degree) with the Agricultural Research Council, Unit of Biometrical Genetics attached to the Department of Genetics in the University of Birmingham, for genetical work on fungi—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 28).

Chemist (with some knowledge of bacteriology, biochemistry, or the chemistry of soils or sewage) in the Chief Engineer's Department at London Headquarters, to study the effects on rivers of power station operations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting NAT/499 (August 28).

Principal Scientific Officer (with an honours degree in science or civil engineering and a knowledge of applied mathematics and physics, and preferably with experience in the application of soil mechanics to civil engineering design and construction), with the Air Ministry at Wellesbourne Mountford, Warwickshire, for work on soil mechanics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1 (August 28).

Lecturer (with an honours degree and a knowledge of advanced physical metallurgy, and an interest in X-ray metallography) in the Department of Metallurgy; and a Lecturer in Dental Bacteriology—The Registrar, The University, Liverpool (September 1).

Lecturer (with special qualifications in plant physiology) in Botany—The Secretary, University of Durham, 38 North Bailey, Durham (September 1).

Microanalyst in the School of Chemistry—The Registrar, The University, Leeds (September 1).

Assistant Lecturer (with an honours or special degree in geography) in Geography—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (September 6).

Lecturer (Grade II) in the Department of Mathematics, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 8).

Assistant Lecturer or Lecturer in Medical Biochemistry—The Registrar, The University, Leeds (September 13).

Chemist (with a first- or second-class honours degree with chemistry as the main subject, and preferably with a knowledge of the natural rubber industry), to operate the advisory service of the Chemical Division, to rubber-producing planters in Malaya, and to investigate problems arising from this work; and a Biochemist (with a first- or second-class honours degree, and able to produce evidence of sufficient postgraduate research experience on biochemical problems to carry out independent investigations), at the Rubber Research Institute of Malaya, Kuala Lumpur, to undertake research work on the biochemistry and enzymology of natural rubber latex, with particular reference to the naturally occurring non-rubber substances—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (September 13).

Leverhulme Fellow and Lecturer (with considerable experience of research work in nuclear physics, and preferably between the ages of 26 and 35 years) in the Department of Physics—The Registrar, The University, Liverpool (October 16).

Aerodynamicists and Aeronautical Engineers (with a first- or second-class honours degree or equivalent in mathematics, physics or engineering, and preferably with research or experimental experience of aircraft problems (Ref. A.215/54A); and Electrical Engineers (with a first- or second-class honours degree or equivalent in electrical engineering, and experimental or research experience in light electrical or electronic fields) (Ref. D.420/54A), at Ministry of Supply Research and Development Establishments, mainly in southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Chemist, Scientific Officer or Senior Scientific Officer grade, to work on new problems arising from the genetics of (1) plant pigments and (2) enzymes in high plants and fungi—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

Experimental Officer (with qualifications equivalent to a pass degree in pure or applied science, and ability to prepare articles describing scientific and technical work in a simple and attractive manner, and preferably with experience in technical writing for industry or in a technical information service), in the Headquarters Office of the Department of Scientific and Industrial Research, for publicity work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.207/54A.

Lecturer in Agricultural Science, including Chemistry, at Winmarleigh Hall, near Garstang—The Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, Preston.

Lecturer (preferably university graduate in science with honours in zoology) in Economic Entomology, at Massey Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Physical Chemist or Physicist (with some experience in research) in the Department of Chemical Engineering, to undertake research on the hydrogen–oxygen fuel cell—The Secretary, Department of Chemical Engineering, University of Cambridge, Tennis Court Road, Cambridge.

Plant Physiologist, and an Agronomist (with good honours degrees), in the Research Division of the Ministry of Agriculture, Sudan Government—The Sudan Agency in London, Sudan House, Cleveland Row, St. James's, London, S.W.1.

Professor of Organic Chemistry—The Registrar, University of Adelaide, Adelaide, South Australia.

Regional Trials Officer (with a degree in botany or agriculture or equivalent qualification, and with practical experience in crop production), for work possibly in Hampshire—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Research Assistant (graduate in agricultural chemistry or chemistry), to undertake work in the field of plant nutrition; and a Demonstrator (graduate in agricultural chemistry or chemistry) in the Department of Agricultural Sciences—The Registrar, The University, Nottingham.

Research Assistant in the Department of Aerodynamics, to assist in research on freon as a medium for high speed wind tunnels—The Recorder, College of Aeronautics, Cranfield, Bletchley.

Research Scholar (with a degree in chemistry) in the Department of Applied Chemistry, to work on the constitution of tars—The Head of the Department of Applied Chemistry, Northampton Polytechnic, St. John Street, London, E.C.1.

Senior Biochemical Technician (Fellow of the Institute of Medical Laboratory Technology, or with a degree in chemistry or equivalent qualification) in the Department of Pathology, to be responsible for routine biochemical investigations—The Hospital Secretary, Canadian Red Cross Memorial Hospital, Taplow, near Maidenhead.

Statistician (with a good degree in mathematics or statistics and some postgraduate training in statistics, and preferably a diploma in statistics, with experience of, or training in, statistical methods as applied to agricultural field experiments), in the Department of Agriculture, Kenya, to advise on the design of field and other experiments conducted by the Department including sampling investigations and surveys, and to assist in the statistical analysis of results—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.63/7/03.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Coal Tar Research Association. Review of Coal Tar Technology. July–December 1953. Vol. 5, Part 2. Pp. ii+79–168. (Gomersal, Leeds: Coal Tar Research Association, 1954.) 7s. 6d. to non-members. [296

Aero Research Technical Notes. Bulletin No. 138: Epoxy Resins. By R. A. Johnson. Pp. 8. (Originally published in *Electronic Engineering*.) (Duxford: Aero Research Limited, 1954.) [296

A General Survey of the British Pharmacopoeia 1953. (A series of lectures by members of the British Pharmacopoeia Commission 1948–1953.) Pp. iv+44. (London: Pharmaceutical Press, 1954.) 4s. 6d. [296

British Welding Research Association. Ninth Annual Report, 1953–54. Pp. 48. (London: British Welding Research Association, 1954.) [296

Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. Pp. 56. (Cmd. 9138.) (London: H.M. Stationery Office, 1954.) 1s. 9d. net. [17

Other Countries

Survey of India. Technical Report 1951. (From 1st April 1950 to 31st March 1951.) Part 1: Topographical and Other Surveys. Part 2: Map Publication and Office Work. Pp. v+48. (Dehra Dun: Office of the Geodetic and Training Circle, Survey of India, 1953.) 5 rupees; 8s. [17

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1952. Pp. xi+57. (Hyderabad-Deccan: Osmania University Press, 1954.) [17

Annals of Library Science. Vol. 1, No. 1 (March 1954.) Pp. 1–64. (Published March, June, September and December.) (Delhi: K. D. Puranik, Times of India Press, 1954.) 20s. per year. [17

Australia. Commonwealth and Industrial Research Organization: Division of Fisheries. Technical Paper No. 2: Commercial Trawling Tests in the Great Australian Bight, 1949–52. By T. W. Houston. Pp. 18. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1954.) [17

Indian Forest Bulletin No. 176 (New Series). Cellulose and Paper. Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board. Part 17: Writing and Printing Papers from Castor Stems (*Ricinus communis*, Linn). By R. V. Bhat and Narendra S. Jaspal. Pp. ii+6. (Delhi: Manager of Publications, 1954.) 8 annas; 9d. [17

Proceedings of the American Academy of Arts and Sciences. Vol. 83, No. 4: Records of Meetings from October 1953 to May 1954. (Summer Number.) Pp. 113–148. (Boston, Mass.: American Academy of Arts and Sciences, 1954.) 75 cents. [57

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